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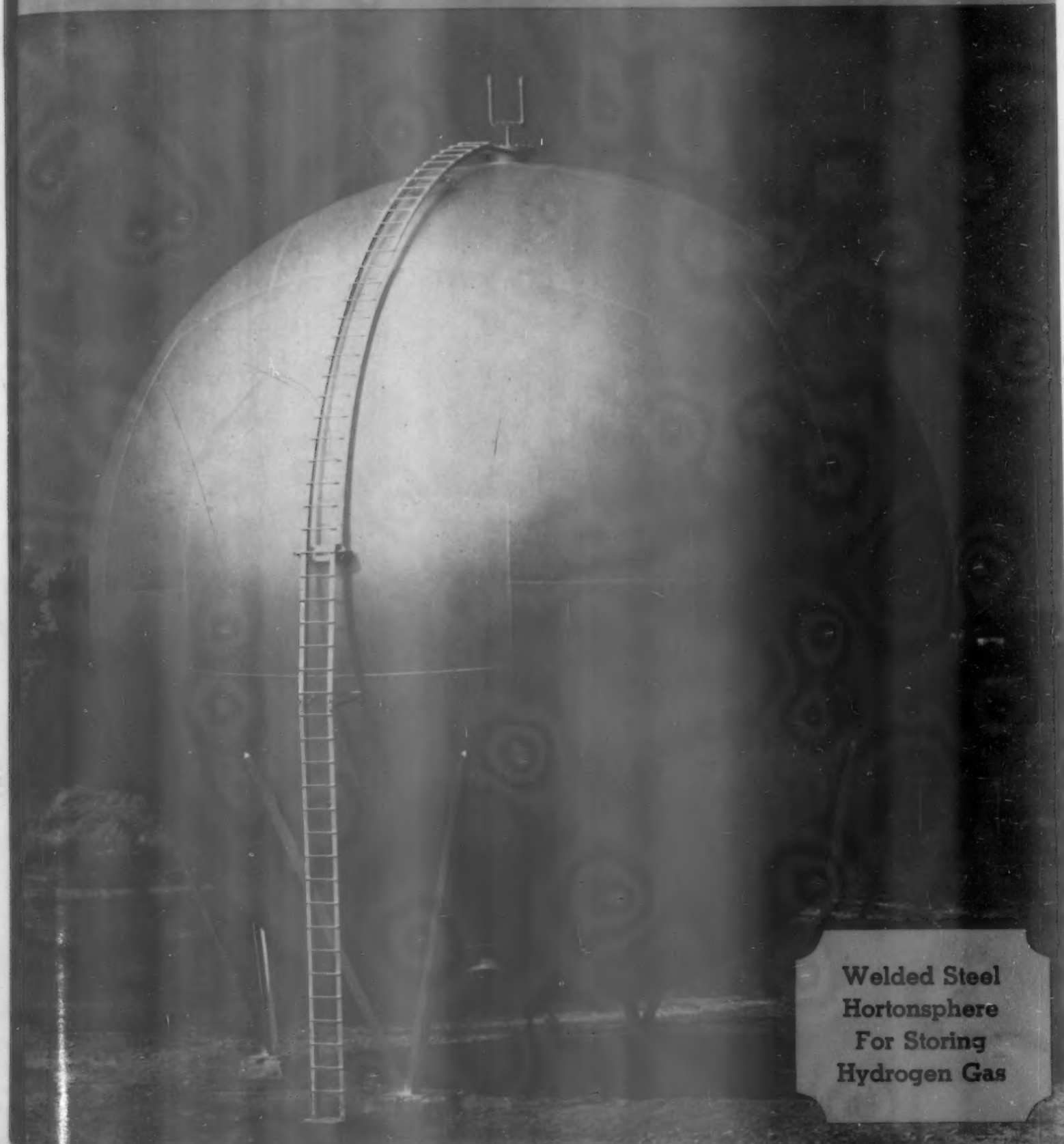
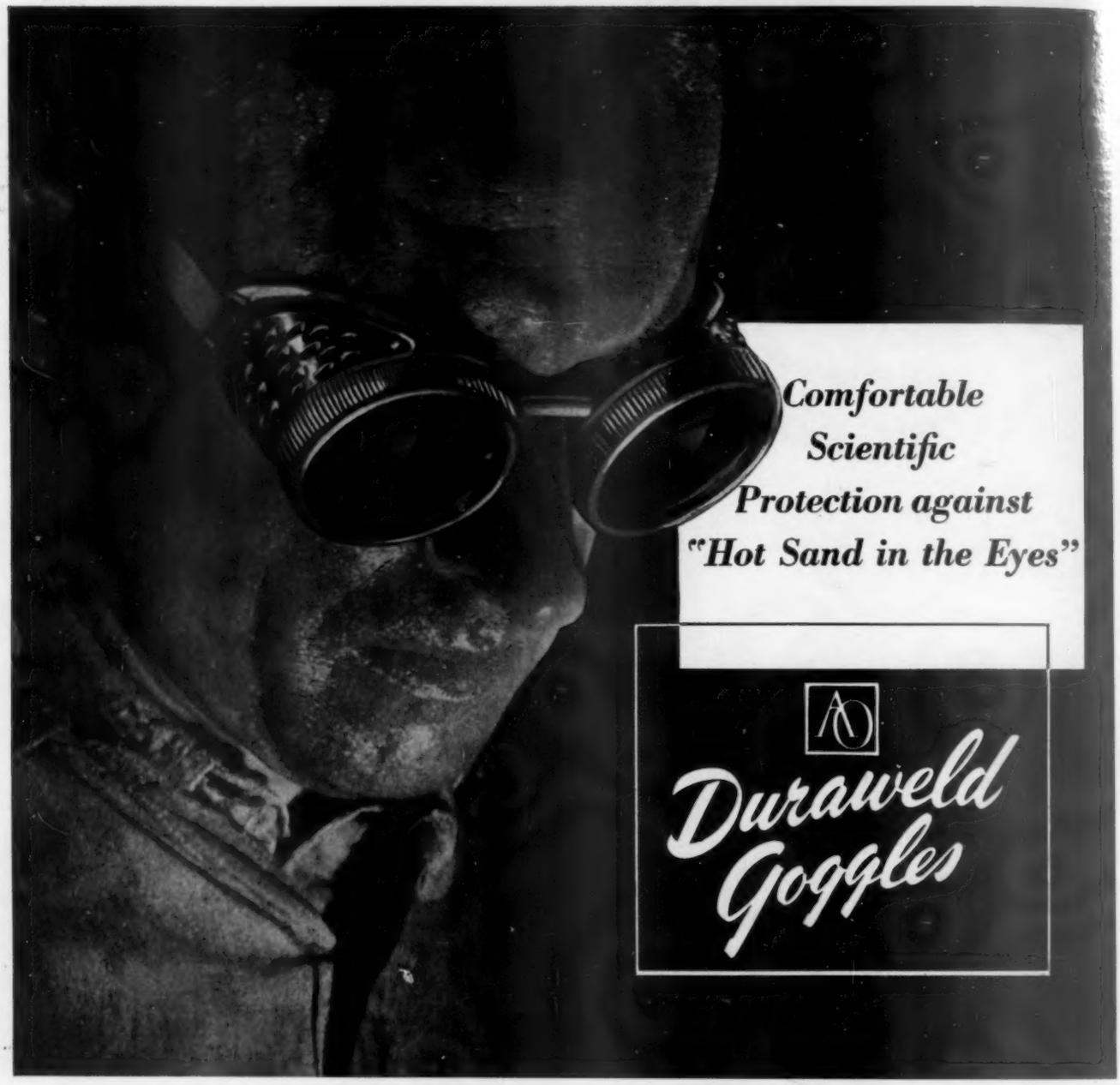


Welded Steel Hortonsphere For Storing Hydrogen Gas



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Eastern Representative:
T. E. DEPEW, 1834 Broadway, New York, N. Y.
Tel. Columbus 5-7843.

Pacific Coast Representative:
W. R. McINTYRE, 446 Western Pacific Bldg.,
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"Welded Steel Hortonsphere for Storing Hydrogen Gas." This 40 ft. diameter welded sphere was built for the Carboloy Co. of Detroit, Mich., to store hydrogen gas at a pressure of 60 psi. Photo, courtesy of Chicago Bridge & Iron Co.

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Is There a Santa Claus?

AFTER LISTENING a few days ago to W. J. Cameron, well known radio commentator and economic interpreter, we felt reasonably sure that there is a Santa Claus. In his simple convincing style, he told us about the abundance of material resources with which we are blessed and the tremendous manpower and scientific research facilities at the disposal of our economic system. Surely, there must be a Santa Claus or we would not find ourselves amidst such a bounteous environment.

At any rate, if there were any lingering doubts in our mind, they were quickly eliminated while on a recent business journey which carried us through some of the principal steel-making centers. Everywhere we found evidence of intense industrial activity which indicated to us that the statisticians were currently telling the truth. We found welding equipment manufacturers enjoying a very satisfactory volume of business and in a very cheerful frame of mind, such as would be expected when business is prospering. Of course, profits may not be all that might be desired in many lines, but it must be admitted that business in our industry at least is quite satisfactory at the year's end.

Will this level of industrial activity continue for long? We are sure a lot of people are asking the same question. Regardless of the answer, we are comforted by the thought that there is a Santa Claus, and apparently he is welding minded. Let us enjoy the fruits of his beneficence while this condition lasts. After all, tomorrow is another day.

Residual Stresses

"FOOLS RUSH IN where angels fear to tread," is an old saying dating back to antiquity. We are reminded of it when we dare to speak or write on the subject of residual stresses. We realize that it is rather foolhardy for an editor to stick his neck out and add to the state of confusion on this much-discussed and much-abused subject. It's like walking into a lion's den to stimulate or participate in a discussion of "locked-up stresses." Despite all of these recognized hazards, we wish to ask some pertinent questions. First, is there any doubt that residual stresses actually exist in a piece of metal directly after welding? We think there is very little doubt about it and hence we suggest that this phase of the subject be dismissed in any practical discussion.

Admitting that we do have residual stresses, it seems to us that several important questions are involved:

(1) What is the approximate magnitude of these stresses? How close do they approach the region of plastic flow?

(2) If plastic flow should take place, is there any danger to human life or property?

(3) Are residual stresses permanently locked up, never diminishing one bit in their intensity?

(4) If these stresses are not permanently "locked up" can they be dissipated internally without resort to special heat treatment?

The real "brain teaser" is involved in this last question. In discussing the subject with several technical men, we found that apparently convincing examples can be found within the range of human experience to prove:

(1) Residual stresses gradually dissipate themselves internally. There is some plastic deformation even at stresses well below the so-called "elastic limit." In fact, research workers at our Bureau of Standards laboratory in Washington, D. C., with the most delicate of precision instruments at their disposal, have reported recently that this so-called "elastic limit" cannot be found. There is no straight-line stress-strain curve as previously contended. In other words, Young's modulus of elasticity (30,000,000 psi./per in.) is after all only a "figure of speech."

(2) Residual stresses do not dissipate their intensity one iota. They are about as permanent as "death and taxes."

We would like to know the answer. Apparently there are conditions when residual stresses will virtually disappear. What are these conditions? When these stresses fail to become dissipated internally, what are the reasons? Let's find out more scientific facts and depend less on prejudicial opinions. What are the controlling factors in stress elimination?

The welding industry needs the answer.

Magnified view of a Tube Borium deposit. Each of the "bumps" is a particle of pure tungsten carbide, one of the hardest and most wear resistant metals ever developed.

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CAPABLE OF CUTTING THROUGH THE HARDEST ROCK

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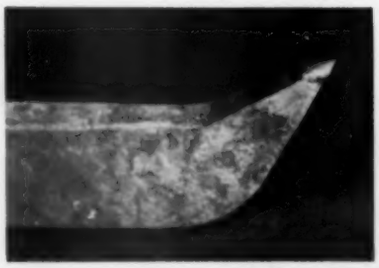
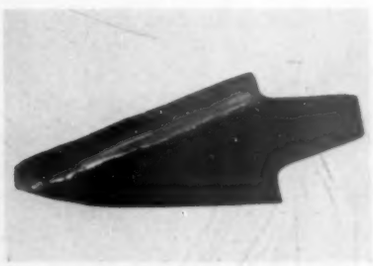


Coal cutter bit tipped with 40-125 mesh Borium. This application not only increases bit life two hundred per cent, but it also greatly decreases the cost per ton of coal produced.

It is accepted practice in all parts of the world to hard-face rotary drilling tools with tube tungsten carbide. Borium is the standard of comparison for other tungsten carbides.



This power shovel tooth outlasted three ordinary manganese teeth, yet it is still sharp.

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Fig. 1—30-ft. diameter pear-shaped "atom-smasher." Photo (Westinghouse).

Design details and field erection of

Arc-Welded Atom-Smasher

★ Several types of joints employed to facilitate field welding. On heavy plates the "basting section sequence" was used to reduce distortion and minimize residual stress

By CHARLES H. JENNINGS
Engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa.

CONSTRUCTION OF ONE of the world's largest units for conducting experiments in the field of nuclear physics is of interest to the welding engineer as well as to the scientist. This unit consists of an all-welded pear-shaped pressure vessel (Fig. 1), 30 ft. in diameter and 47 ft. high, housing an electrostatic direct-current generator, a steel electrode 15 ft. in diameter and other parts including a 40-ft. vacuum tube, through which ions are "shot" in the bombarding of various types of targets. The structure, including a two-story building, is 65 ft. high or about as tall as a six-story building.

Voltages generated in the "atom-smasher" will range up to 5,000,000. Such high voltages will accelerate ions "shot" through the vacuum tube up to 100-million miles an hour! These speeding ions will leap from the end of the vacuum tube through thin metal windows and strike the targets with a velocity great enough to penetrate hard centers, or nuclei of the atoms.

The generation of high voltages is dependent upon proper insulation of the electrode carrying the charge. The tank proper is essentially a means of obtaining this insulation. By subjecting the tank to internal air pressure, the breakdown strength between the electrode and ground can be increased.

Design of Tank

The pear-shaped tank was designed and erected by the Chicago Bridge and Iron Co. A drawing giving the essential details of the design and welded joints is shown in Fig. 2. This tank is of particular importance because it is, to our knowledge, the first pear-shaped vessel of its size to be constructed and it contains the heaviest plate sections (1¾ in. thick) to be welded in the field without subsequent stress relieving. Low carbon steel plates having a tensile strength of 55,000 to 65,000 psi. were used throughout.

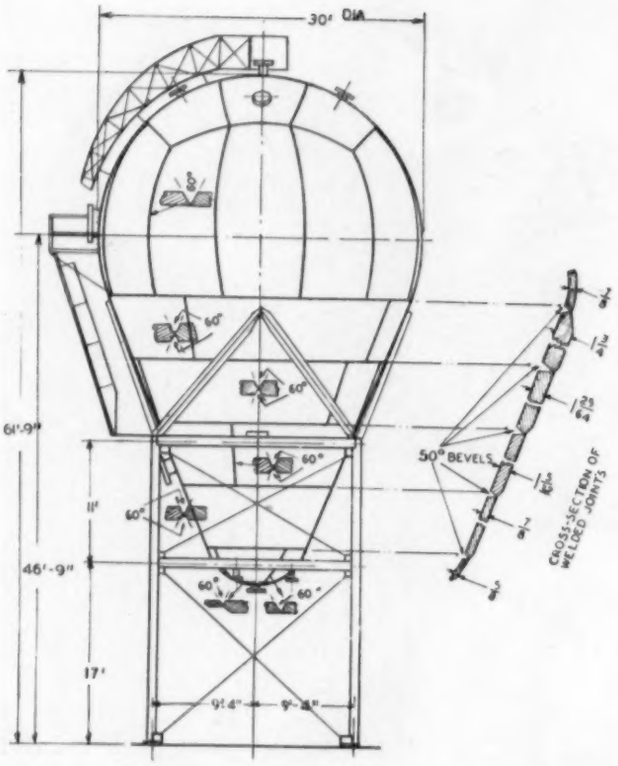

Fig. 2—Details of welded joints on the "atom-smasher."

Modified double "U" joints were used on the vertical seams of the conical section. Single vee joints were used on all other seams. In order to eliminate overhead welding as much as possible, the seams in the conical and lower spherical portions were designed to permit the major portions of the welding to be done from the inside of the tank. The seams on the upper spherical portion were designed to permit the major part of the welding from the outside of the tank.

The tank is designed to operate at 120 psi. air pressure. Because of its size and other design features it was impractical to test it hydrostatically. Consequently, a pneumatic pressure test was made to test the finished tank.

Construction of Tank

The spherical plates for the tank were formed at the Greenville, Pa., plant of the Chicago Bridge and Iron Co. and temporarily shop asesmbled to insure a proper fit. The conical plates were formed in the Chicago plant and also temporarily shop assembled to insure a proper fit. As a result, a very excellent fit-up was obtained on all joints in the final field erection.

All nozzles and manholes were shop welded to their respective plate sections except in the case of the bottom 14-in. nozzle. This nozzle was joined to the four bottom spherical plates and consequently was field welded.

All seams on the tank were field welded in position. This meant a great deal of vertical and overhead welding (Fig. 3). Westinghouse "Crucible Weld-AP" electrodes of 5/32 in. and 3/16 in. diameters were used in all cases. These electrodes produced welds with tensile strengths of 60,000 to 70,000 psi. and ductilities of 25-30% elongation in 2 in.

All welders were qualified by making test plates similar to those required for Paragraph U-69 welding of the A.S.M.E. Unfired Pressure Vessel Code. The welding position (vertical, overhead, etc.) used in making the test plates, corresponded to the position in which the welder worked on the actual tank.

In constructing the tank, the supporting structure was erected first and then the No. 4 ring. After the No. 4 ring was securely clamped and tacked into place, the other bottom rings were attached. Following this the two upper conical rings were attached. During the assembly of the upper conical rings, the vertical seams on the lower rings were welded. Vertical seams were welded first in all cases. No circumferential seams were welded until the vertical seams on the plates comprising the circumferential seams were finished.

Following the assembly of the conical section the complete upper spherical section was assembled. After securely tack-welding the vertical plates in place the three top plates were again removed. This aided in ventilating the inside of the tank while welding and made possible the insertion of the 15-ft. diameter electrode which was field welded and had to be placed inside the tank before it was permanently closed. Figure 4 shows the electrode being lowered into the tank. After the electrode was placed inside the tank the three top plates were again attached to the tank and welded in place.

All vertical welds were made by weaving and welding upward. The only downward welding done on vertical joints was done on the finish pass of the weld. Overhead and horizontal welds were made in string beads.

In order to prevent high residual stresses and excessive distortion when

Fig. 3—Attaching the 14-in. nozzle by means of overhead welding. Looking up at the bottom of the pear-shaped vessel.

Fig. 4—Workmen are placing the 15-ft. diameter electrode in the "atom-smasher."

welding the heavy plates the so-called "basting section sequence" was used.* The welding on the conical section progressed downward, while the welding on the upper spherical section progressed as shown in Fig. 5. The circumferential welds were also made by using a similar procedure.

All welds were thoroughly cleaned between layers and questionable spots chipped out to insure sound metal. The reverse side of each joint was chipped to sound metal before depositing metal on the finished side. Because of electrical reasons, it was necessary that the tank have a smooth interior. As a result, all inside welds were reinforced ⅛ in. and then ground flush. This procedure of reinforcing the weld before grinding it flush insured a weld of fine grain structure the full thickness of the plate.

Approximately 3800 lbs. of electrodes were used in the field erection and 750 lbs. of electrodes in the shop welding. There were 730 linear ft. of welding on the tank and 130 linear ft. of welding on the electrode.

*See "Fundamentals of Welding" by J. W. Owens, page 259, Penton Publishing Co., 1923.

Pressure Test

The acceptance pressure tests on the "atom-smasher" consisted of subjecting the vessel to air pressure and giving all the welds a soap test. The first test consisted of applying 70 psi. pressure, making a soap test, and then increasing the pressure to 120 psi. (design working pressure). No leaks were found.

The pressure of 120 psi. was held for about ½ hr., following which a gate valve was opened and the pressure reduced to atmospheric. Immediately upon reaching atmospheric pressure the gate valve was again closed and a second pressure test started.

The second pressure test consisted of raising the pressure to 160 psi., holding it for about 14 hrs., reducing it to 120 psi. and giving every weld another soap test. Following the soap test the air was drained from the tank. No leaks were found on the second soap test.

The A.P.I.-A.S.M.E. Code for Unfired Pressure Vessels requires a pneumatic test of 110% of the calculated working pressure in cases where the vessel is not capable of supporting the weight of liquids. The pressure test applied to the "atom-smasher" was 133⅓% of the designated working pressure, or 23⅓% in excess of the Code requirements.

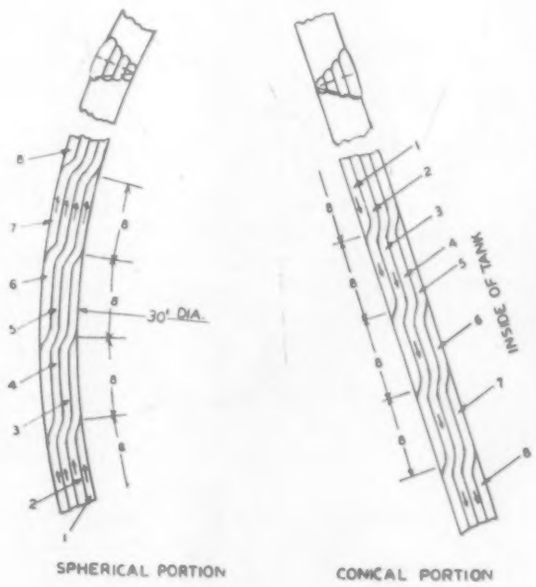

Fig. 5—"Basting section sequence" of depositing beads in vertical joints.

Oxy-acetylene welding was employed to join hexagonal aluminum alloy tubes into a honeycomb pattern for an aeronautical wind tunnel. Photo (Aluminum Co. of America).

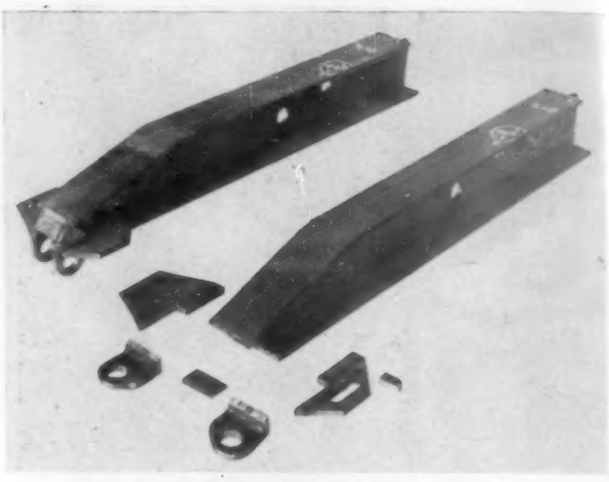

Fig. 5—One of the sub-assemblies (a side member) before and after welding. Shown upside down to bring out details.

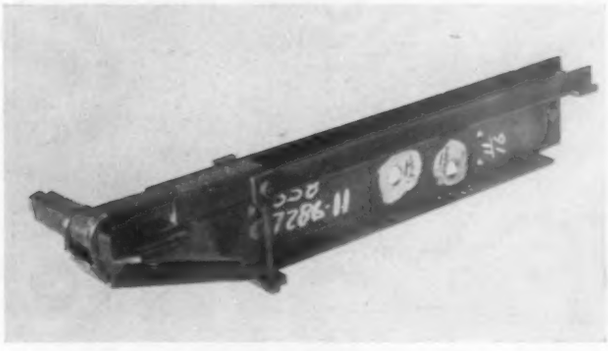

Fig. 6—To secure absolute alignment of connection holes, all parts are welded in this fixture.

Redesign for arc welding of a

Power Shovel Turntable Bed

★ Part 2—Detailed outline of welding procedure followed in the shop fabrication. Assembly fixtures hold parts in perfect alignment. Appearance is held to be important

By R. H. ZEILMAN*

Assistant Chief Engineer, The Thew Shovel Co., Lorain, Ohio

IN THE MANUFACTURING process of the structural rear bed a definite routine or procedure is followed. A "Welded Assembly Bill of Material" together with detail blueprints of the various parts is furnished the structural shop. The complete unit carries a basic part number and each individual part going into it carries a numerical suffix identifying it with the complete unit.

The assembly is treated as an aggregate of parts only in the welding shop. When it leaves the welding shop, completely assembled, it is treated as a complete unit and carries a basic part number just as if it were a casting. This procedure greatly simplifies handling the parts on the basic "Bill of Material" for the complete machine. All welded assemblies are handled in the same manner.

Preparation of Material

This "Bill of Material" goes into the structural shop where the first step in the production of the structural welded rear bed is to assemble the raw materials in the forms of rolled steel shapes and plates. After proper laying out, these parts are prepared by shearing, machine flame-cutting or by hand torches, whichever the shape or the

*One of the Award Winners in the $200,000 Award Program of the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. This is the second and final section of this prize-winning paper.

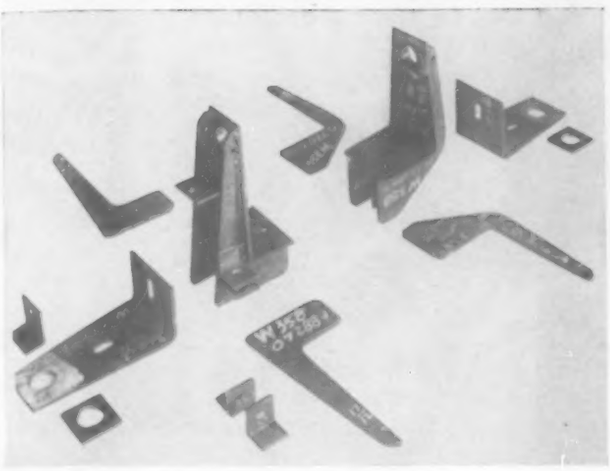

Fig. 7 — Boom drum bracket. Both the parts and the completely welded bracket are shown.

piece and economy dictates. In machine flame-cutting the torch is controlled by a stylus following an accurate template to insure uniformity in the finished pieces.

Following the shaping of the pieces, all the holes required in the final bed are laid out on the individual pieces. By virtue of having smaller, lighter pieces to handle, all these holes are drilled on drill presses, giving a considerable economy over the handling of a difficult bulky casting requiring a more expensive boring mill operation.

Welded Sub-Assemblies

With all the necessary shapes cut out and with all the holes drilled in them, the next step is to proceed with the sub-assemblies. There are five such sub-assemblies:

1. Sub-Assembly No. 1 — The Rear Channel. This channel forms the rear of the bed. The flanges of this channel are cut through at a distance of 17 in. in from each end, and the ends are swung in to form a bay-shaped piece. The cuts in the flanges are then welded closed. Two small reinforcing lugs are also welded to the inside of the top flange where the holes for the supporting struts have been drilled.

2. Sub-Assemblies Nos. 2 & 3— Side Members. There are also two side or longitudinal members fabricated as sub-assemblies. These are identical and are each handled in the same manner, except one is a right and one a left side piece.

Each of these members consists of the assembly and welding of 7 parts or pieces. In Fig. 5, the lower view shows all the parts of this member prior to assembly and welding. The upper view in Fig. 5 shows a complete, welded side member. In order to show these parts plainly on photographs, the members in Fig. 5 are shown upside down. In actual use the connecting lugs or jaws at the front are located so as to project upwards.

In considering these members, it should be kept in mind that the rear bed supports approximately three tons of weight all of which is located at its extreme rear. Thus, as the turntable is in operation and is swung back and forth through an arc of 45 deg. to 90 deg., from 2 to 4 times a minute, the inertia developed by this weight is tremendous. Such inertia has a considerable tendency to set up high stresses and loads in the connections of the rear bed to the front bed.

The connection holes at the front of these members are the only means of such attachment to the front bed. Therefore, considerable attention was given to the design of these connections. To assure the absolute alignment of these connecting holes, as well as the balance of the member, all of the parts of this assembly are welded in a positioning and welding fixture. Figure 6 shows such a sub-assembly, completely welded just prior to its removal from the fixture.

The longitudinal members are 6 in. by 4 in.—16 lbs. C.B. sections. The webs are flame-cut back along the lower flanges for a distance of 12 in. and a triangular piece is flame-cut out of the web. The lower flange is then bent upward and rejoined to the web by a butt weld coming in from each side.

The parts that form the jaws of the connections to the front bed are cut from rolled angles with the inside leg flame-cut to the proper length and with this edge "Vee'd" to provide for a butt weld. This portion of the angle is butted against the web of the C.B. section and is joined to it by a butt weld, while the ends of the angles are joined to the flanges of the C.B. section by fillet welds. The two sides of the jaw formed by the upstanding legs of the angles are tied together by a small bar, thus insuring that any lateral loads will be distributed over both sides of the jaws. The holes in these connecting jaws, of course, are drilled before the assembly and welding and are held in perfect alignment for welding by means of the welding fixture.

The angle legs of the jaws are stiffened against lateral bending by plates, suitably flame-cut to pass along the sides of the angles to a point near the pin hole, and extending back a considerable distance under the flanges of the C.B. section.

The outer or rear edges of the longitudinal members are coped to fit into the lower flanges of the rear cross channel (Sub-Assembly No. 1) and are butt welded at the flange and fillet welded at the web. This latter operation is done in the final assembly.

3. Sub-Assemblies Nos. 4 & 5— Boom Drum Bracket. These sub-assemblies consist of the two halves of the bracket supplying the support for the boom derricking drum pin, and the housing for the drum. The various parts making up each half of this bracket, are shown in Fig. 7, grouped, in each case, around a view of a completely assembled and welded bracket which the parts form.

Perfect Alignment

Here again absolute, perfect alignment of all parts is essential, as these assemblies must fit properly into the main or final positioning fixture and all holes, which are already drilled in the various pieces must fall into their proper relationship and alignment. Therefore, to maintain the accurate relationship of all parts while welding, these brackets are assembled in a special welding fixture. This fixture is arranged to pivot and swing to give the proper positions and accessibility for speedy welding. It accommodates both halves of the bracket at once. All parts for one bracket can be assembled in one half of the fixture, the other part of the fixture being left empty, ready for the assembly of the other half. In the welding of the brackets fillet welding is employed throughout.

The next step is the final assembly of the above mentioned five sub-

assemblies. To assemble and weld the five sub-assemblies into a completed structural rear bed, a special positioning and welding fixture has been developed to hold all the sub-assemblies and the other necessary channels and plates in their correct relationship to prevent any necessity of later having to plane any surfaces and drill any holes.

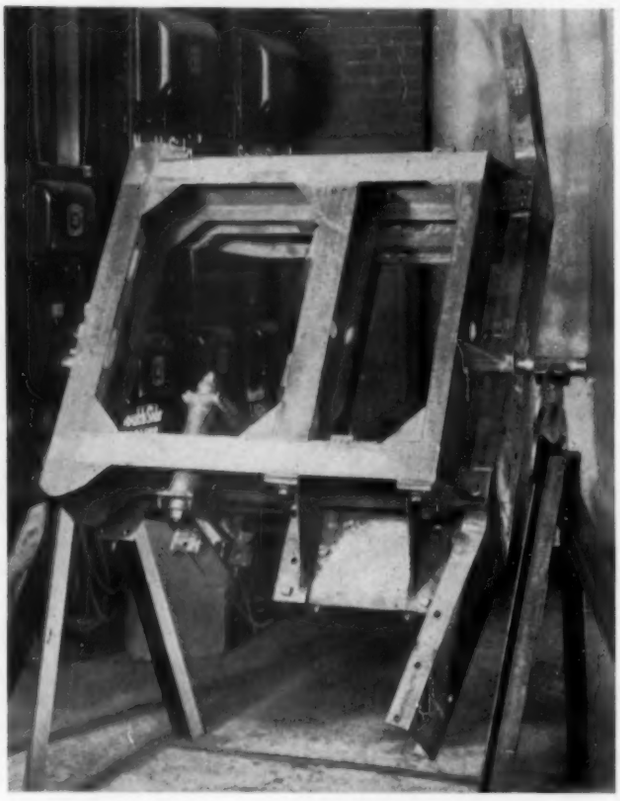

Fig. 8—This positioning and welding fixture holds the five sub-assemblies in welding the structural rear bed. Looking down on the top of bed.

Figure 8 shows a top view of this fixture with a rear bed in it. In this case all the sub-assemblies and other plates have been assembled in the fixture and have been welded together into a unit which is ready for removal from the fixture.

Figure 9 shows the bottom view of the same fixture with the completely assembled rear bed in place. This fixture is supported on two trunnions located to balance the fixture and bed, so it can be revolved for accessibility in welding. A brake on one trunnion prevents any chance of the assembly turning.

Fig. 9—Bottom view of the same welding fixture with a completed rear bed in place. Note trunnion supports for fixture.

Final Assembly Procedure

It is essential in the final rear bed that absolute alignment exist between the holes at the front of the side members (Sub-Assemblies 2 & 3) and also between the holes of the boom derricking drum bracket (Sub-Assemblies 4 & 5). Therefore, the following procedure is followed in placing the sub-assemblies into the final welding fixture.

First, the flat rectangular plates for the engine support, etc. are placed in the fixture and are bolted into position. This fixes them in the correct horizontal planes as well as in the proper relationship laterally.

Secondly, the two side members (Sub-Assemblies 2 & 3) are placed in position. The front holes or connecting lugs or jaws of each of these are accurately lined up and fixed in position by drive fit pins through positioning holes in the fixture. Guides at the sides of the fixture enable lining up the correct position of the side members for accurate spacing between them.

Third, the center channel spacer between the side members is put into position and fitted against guides in the fixture which locate it accurately. Clamps are then used to hold it in correct position. The ends of this member are coped to fit into the flanges and webs of the C.B. sections of the side members.

Fourth, at this point the side members are given a tack weld to the horizontal plates at the back of the bed in order to assure them holding their position.

Sixth, the boom derricking drum brackets are installed next. These are positioned by means of the holes for the boom derricking drum pins which are fitted over a pin located in the fixture. Bushings and spacers are utilized to space these brackets the correct distance apart. Once they have been properly positioned, a large bolt replaces the pin in the fixture and the parts are drawn up tight and square.

The work of welding all these units together is the next step and the entire unit is revolved as necessary to give the welder all the necessary ac-

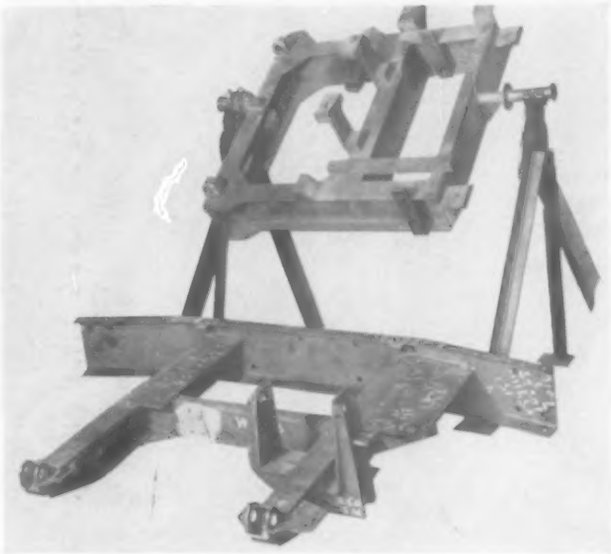

Fig. 10—Completely assembled and welded rear bed ready for the assembly line.

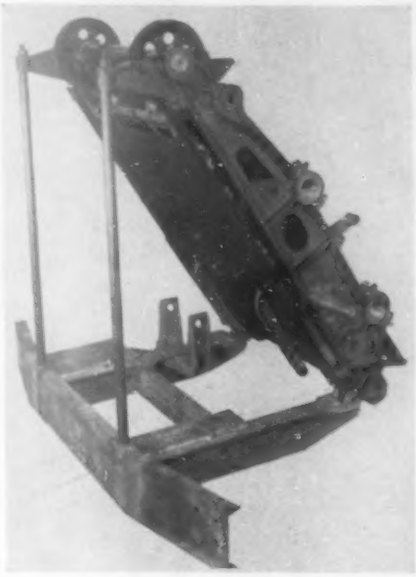

Fig. 11—Welded rear bed assembly connected to the sloping machinery frame. First step of the final assembly of complete turntable.

cessibility in handling the job quickly and efficiently. A welding procedure is followed, based on tests and experience, which tends to eliminate as much warping, etc. as possible. Since the metal sections throughout are comparatively light, practically all the welding of the final assembly, as well as on most of the sub-assemblies, consists of 5/16-in. fillet welds.

Figure 10 shows a completely assembled and welded rear bed ready for removal to the main assembly line for installation on a machine. The details of the positioning and welding fixture are shown in the unit behind it.

When the all-welded rear bed leaves the welding shop it is ready for assembly on the machine proper. There are no further machining operations required on the completed assembly. In the all-welded structural bed, all the necessary holes are drilled in the smaller, individual pieces on a drill press prior to assembly. All necessary level surfaces are obtained by using rolled shapes correctly positioned in the proper relationship, thus all planing operations are eliminated.

Final Assembly

Figure 11 shows the first step of the final assembly of the complete turntable. The welded rear bed assembly is shown connected to the sloping machinery frame. This entire unit is next joined to the front bed. At this point the installation of the engine and of the power shafts and operating levers is made, to complete the turntable assembly. At this point the unit is ready to be mounted on the crawler, to have the boom installed, and to go on test.

The policy of this company is to put appearance second to utility and in all designs the question of appearance is considered carefully. This policy has applied to the design of the rear bed. Figure 11 shows an all-welded structural rear bed attached to the sloping machinery frame, the entire unit being ready for assembly in the finished machine. In no way has anything been done to cheapen or lessen the appearance of the product or to reduce its utility.

It has been for improved and finished appearance that the ends of many parts of the welded assembly have been coped. In several cases a more simple connection would have served, but would not have carried with it the appearance and effect of careful design; of stronger, better construction; of improved appearance.

An analysis of the design will indicate also that more welding has been used throughout than is necessary for strength. In many cases tack or staggered welds would have sufficed. However, the additional cost of the use of continuous welds throughout was considered justified by the improved appearance and sales advantage thus gained.

Other Advantages of the Redesign

There are three additional results that should be considered as advantages of the redesign:

1. The reduction of 8.5 hrs. of machine tool time per unit. This releases these units for other uses and in effect increases machine shop productivity without additional investment in equipment.

2. The use of more direct labor on the welded bed permits the welded assembly to carry more labor overhead while total costs are reduced 34.4%.

3. The previous casting weighed 570 lbs. The welded assembly weighs 415 lbs., a reduction of 155 lbs. Since light weight, without sacrifice of strength, is being constantly striven for in shovel design because of its operating advantages, the redesign was helpful in this respect also.

New prison chapel at Auburn, N. Y., has an all-welded steel frame. Photo (Wilson Welder & Metals Co., Inc.).

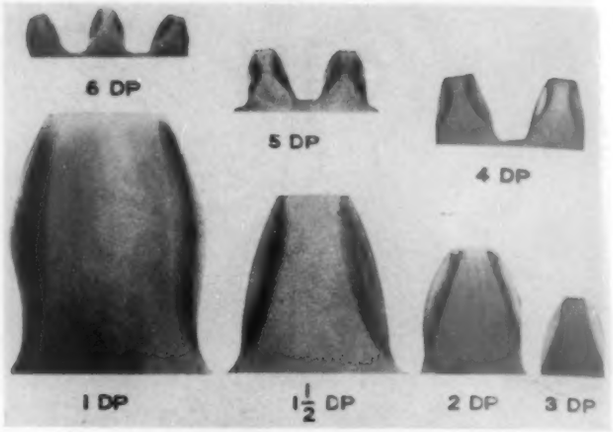

Fig. 7—Typical sections of flame-hardened gear teeth from 1 to 6 diametral pitch.

Review of recent technical developments in

Flame-Treating Applications

★ Part 2—Flame-softening has numerous industrial applications, particularly in conjunction with flame-cutting. Highly stressed parts can be locally strengthened

By J. H. ZIMMERMAN*
Development Engineer, The Linde Air Products Co., New York City

WITH RESPECT to the results to be obtained by the proper application of flame-hardening methods, a number of macro-etches have been included. In Fig. 7 is shown a group of etched flame-hardened gear teeth ranging from 1 to 6 D.P. Unfortunately, the teeth shown represent a number of steels and considerable variation in etching and photographic technique. However, the typical contour of the hardened region is well illustrated.

Fig. 8-a is a macro-etch of a flame-hardened cam which shows concentration of hardness at the surface subjected to highest contact loads. In Figs. 8-b and 8-c are shown macro-etches of two rounds which have been hardened by the combination method. Attention is called to the uniformity of case in each example and to the range of controlled case depth.

Previous reference has been made to the flame-hardening of crankshaft bearings by the spinning method. The result obtained by the crankshaft set-up shown in Fig. 5 is illustrated in the longitudinal etch of a hardened shaft, Fig. 8-f.

Other interesting illustrations of the economical placement of hardened metal are shown in the sectioned caster race, Fig. 8-d, the pressure screw thread, Fig. 8-e, the partially sectioned detachable rock drill bit shown in Fig. 8-g, and the sectional flame-hardened sheave wheel, Fig. 8-h. The flame-hardened sheave wheel shown illustrates the extreme flexibility of the flame-hardening process with respect to confinement of hardened material in the regions where hardness is essential.

Diametrically opposed to the basic demands for the flame-hardening processes are the needs which have led to the development of a somewhat newer procedure known as "flame-softening." Where the objective in the first process is to increase surface hardness, the purpose in the second is to soften material which has been, or might otherwise become, hardened. The numerous industrial applications of flame-softening include: the local annealing of carburized or cyanided case-hardened parts to permit drilling, tapping or machining; the same with respect to fully hardened parts; the local softening and refining of finishing weld passes; the annealing of sheared edges and other work-hardened parts; the softening of such parts as flame-cut riser pads. Another application of flame-softening is in connection with

*Final installment of the author's paper as presented before the recent annual meeting of the American Welding Society in Chicago, Ill.

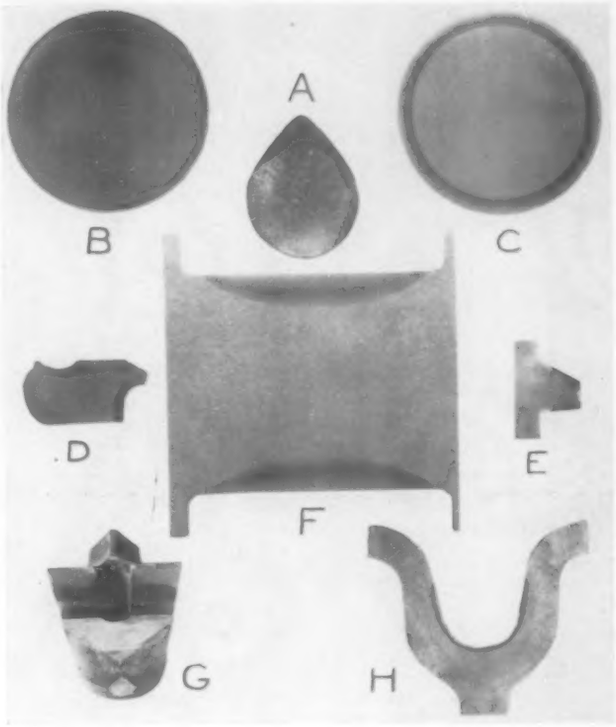

Fig. 8—Macroetches of representative flame-hardened parts. (a) Cast iron cam, (b) shaft with light case, (c) shaft with deep case, (d) section through flame-hardened caster race, (e) pressure screw thread, (f) longitudinal section of flame-hardened crankshaft bearing, (g) partially sectioned detachable drill bit, and (h) sectioned cast-iron sheave wheel.

the flame-cutting of the air-hardening steels, with particular reference to steels of the alloy and high-tensile structural types. These, when flame-cut by the usual methods, may harden sufficiently to leave cut edges which are lacking in toughness, ductility and, in some instances, machinability.

The fundamental action of flame-softening when used in conjunction with flame-cutting is in supplying such preheat, postheat or both, as may be necessary to leave the cut edge in an acceptably softened and ductile condition. There are three methods of using flame-softening heads for the removal of hardness from cut surfaces. As the first example, a single heating head may be applied to the top of a plate which is being flame-cut. The heat is applied simultaneously with and immediately before or after the cut has been made. The effect is either to slow the rate of cooling to a sufficient extent to prevent undue hardening, or to temper the partially hardened cut surface.

A second process employing the simultaneous application of heat from both the top and bottom of the plate may be used. This procedure is more desirable when the thickness is such as to make heating from one side only economical or destructive to the top surface, because of the longer soaking time required. The second setup is restricted to cuts where a relatively thin width of scrap is removed. The third method of flame-softening involves the application of the softening flames directly to the cut surface immediately after the cut has been completed.

By employing one of the foregoing flame-softening processes it is possible to flame-cut materials which otherwise would require expensive machining. Use of the process also eliminates the need for chipping or grinding away the thin hardened surface which is left on the hardenable steels when the ordinary methods of flame-cutting are employed.

While the results obtained by the use of the flame-softening process in connection with flame-cutting may be generally duplicated by furnace-treatment of the plates as a whole, either by preheating before cutting or by heat-treating after cutting, appreciable savings can be realized by the use of the flame-softening process instead of the more cumbersome and less economical methods of furnace-treating.

PRINCIPLES—The underlying principles of the flame-softening process are predicated upon the accepted metallurgical bases of other well-known heat-treatments. The temperature gradients set up by ordinary flame-cutting may be quite steep, and it is reasonable to expect, under such conditions, that a thin layer of the surface material will be subjected to a fairly rapid rate of cooling, because of radiation to the surrounding air and conduction to the cold base metal. The softening of these gradients may be accomplished by the use of the preheating treatment and, as is well known, with the corresponding reduction in rate of cooling, the subsequent hardening is negligible.

With further respect to the simultaneous application of heat with cutting, it is also possible to employ post-heating effectively. This treatment may consist of a tempering of the previously hardened metal by reheating to a temperature slightly below the critical, or it may involve reheating the surface metal to an annealing temperature slightly above the critical. With the broad temperature gradient set up and the deep volume of heated material, the rate of cooling is such as to leave the material in a relatively soft, ductile condition.

Post-Heating

In considering the third method of flame-softening it is assumed that prior to the application of the treatment the work has been flame-cut and cooled to a temperature below the critical. Generally speaking, the sooner thereafter that the softening treatment can be applied, the better, since the more delicate steels will sometimes crack if cooling is allowed to progress to shop temperature, particularly in cold weather. By applying heat directly to the face of the cut, a straight tempering treatment may be accomplished, or, if a more thorough-going treatment is desired, a complete treatment may be applied consisting of heating the cut surface to slightly above the critical, thus refining the previously coarsened material, following with either a tempering to a high tempering temperature, or a cooling, reduced in rate by the application of a second bank of heating flames.

RESULTS—The results obtained in applying flame-softening are illustrated graphically in Fig. 9. Some steels normally respond to the ordinary flame-cutting process by hardening at the cut surfaces to from 200 to 500 Brinell. However, when properly treated by either preheat or postheat in conjunction with cutting, these steels respond to the combined cutting and treating by hardening to an acceptable degree, usually to within the range of 150 to 300 Brinell. The general effect of the treatment on a repre-

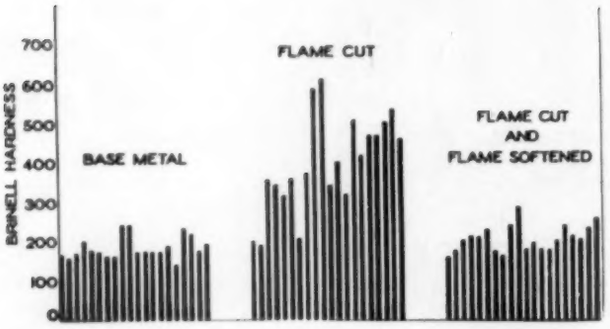

Fig. 9—Brinell hardness at the cut surface of a group of representative high-tensile and low-alloy steels — as received, as flame-cut, and as flame-cut and flame-softened.

sentative group of steels is clearly shown in Fig. 9.

A striking example of the utility of the flame-softening process is in the softening of flame-cut armor plate. In this application, appreciable savings and notable increases in production have been realized through the substitution of flame heat-treatment for full furnace-treatment.

Flame-Strengthening

GENERAL—Of the three flame-treating processes described in this paper, the third, flame-strengthening, is the newest and least known. It is, however, self-defining by name. In application it is practically identical with the flame-hardening treatment. The purpose of flame-strengthening differs appreciably from that of the above-mentioned processes, however, in that the intent is to strengthen highly-stressed parts locally in the regions of excessive concentration of stress. An example of such stress concentration, as determined photo-elastically, is shown in Fig. 10.

The process is directed particularly at parts which are to be subjected to repeated stresses and which are thus subject to failure by fatigue. In protecting against fatigue failures it is again—to borrow the slogan of a well-known paint manufacturer—a case of "save the surface and you save all." In other words, while the treatment may appear to be identical with flame-hardening, it may be applied to sections of a part, which will never be subjected to wear, for the specific purpose of increasing mechanical strength as resistance against the formation and propagation of fatigue cracks. By virtue of the extreme flexibility of the process, the use of flame-strengthening makes it possible to effect savings in comparison with the complete heat-treatments where, in many instances, 100 per cent of a part would be fully hardened and drawn in order to increase the strength of the 1 per cent

Fig. 10—Photo-elastic study showing stress concentration at shallow grooves in pure bending.

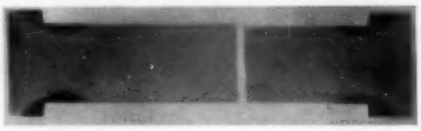

Fig. 11—Macroetch of failed fatigue test specimen showing flame-strengthening at the regions of stress concentration.

which may be subjected to the maximum stresses.

METHODS—As previously stated, there is practically no difference between the flame-strengthening procedure and that for flame-hardening. In order to produce the desired contours of strengthened metal and in order to control the fadeout of this strengthened section into the base metal in regions of lower stress, and thus prevent sharp discontinuities, it has been found desirable to employ special heating heads where the complexity of the part does not lend itself readily to the use of simple or standard equipment.

The cooling in the flame-strengthening process may be somewhat less drastic than in the case of flame-hardening. Whereas it is generally agreed that high hardness is indicative of great strength, unfortunately, the strength so indicated is not, in turn, indicative of the maximum fatigue or endurance properties. Somewhat lower than maximum hardnesses have been shown to be advantageous with regard to resistance to repeated stresses. This is probably caused by the need for a certain amount of ductility to provide for minute plastic deformations in regions of high stress concentration. The need for tempering, even though at a low temperature, is even more obvious in the case of flame-strengthening than in the case of flame-hardening.

Results of Tests

RESULTS—While no specific information concerning the performance of flame-strengthened parts in service is as yet available, the results of laboratory tests are of interest. In Fig. 11 is shown part of a sectioned and etched fatigue specimen of the type employed in a series of tests to determine the advantages of the flame-strengthening process. In this specimen a sharp shoulder was intentionally introduced in the midsection of the test specimen which is submitted to uniform bending during rotation. As is well known, and as has been previously indicated by the photoelastic illustration in Fig. 10, this abrupt change in section is a stress raiser of appreciable magnitude. It was thought that if flame-strengthening could divert the fatigue failure from the sharp cornered fillet to the shank of uniform diameter, the treatment, in effect, would have completely

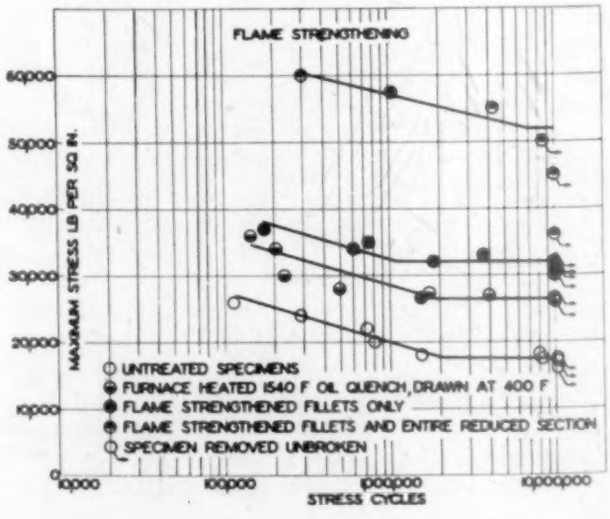

Fig. 12—Graphical representation of fatigue test results showing determination of endurance limits.

eliminated the weakening effect of the stress raiser. This has been found to be the case, as is shown by Fig. 11 which is a longitudinal section of a fractured specimen showing the break at the center.

In order to investigate further the effect of flame-strengthening, the entire reduced section surface, as well as the fillets, was strengthened in a second series of specimens. In these tests it was soon found possible to throw the fatigue failures to the untreated metal in the sections of large diameter. Actual dimensions of the specimens under test were 7/16 in. and ½ in. for the small and large diameters respectively. This variation in diameter corresponds to a much greater difference in the induced stress under load, the ratio of stresses for a uniform bending moment being almost 1.5:1.

Endurance Limits

The results of one series of comparative fatigue tests are shown in Fig. 12. The endurance limits for four sets of specimens of the same type but of different treatment are shown. The base material in this series of tests was S.A.E. 1045 steel. No attempt was made to determine the actual endurance limit of the material, which is probably in the neighborhood of 45,000 psi. Instead, the calculated stresses for the test specimens were based on the small diameter without regard to the stress raising factor corresponding to the sharp cornered shoulder.

In the lower curve it will be seen that the nominal endurance limit of the test specimen, untreated, was in the neighborhood of 18,000 psi. If it is assumed that the test material itself has an endurance limit of 45,000 psi., the actual stress raising factor indicated is 2.5, a value which is not inconsistent with published data.*

In the second curve from the bottom, the nominal endurance limit is indicated to be approximately 26,000 psi. This series of specimens was oil-quenched from 1,540 deg. F. and drawn at 400 deg. F.

The next curve showing a nominal endurance limit of 32,000 psi. corresponds to the series of specimens treated as indicated in Fig. 11, namely, untreated base metal with flame-strengthened fillets. It is interesting to note that this relatively sparse heat-treatment has developed improved fatigue resistance as compared with a fully quenched and drawn specimen, although it must be admitted that the fully hardened specimens would probably have shown improved results had they been water-quenched.

The upper curve, indicating a nominal fatigue limit around 52,000 psi. was obtained in testing a series of specimens which had been flame-strengthened not only at the fillets but across the entire reduced section. The improvement is obvious.

The results of these and other laboratory tests in progress indicate that there may be considerable future for the flame-strengthening process.

Conclusion

In conclusion, it may be said that, first, while flame-hardening, as a process, is no longer new, applications continue to become more numerous, and it is believed that flame-hardening, as a method of heat-treating, has definitely established itself as being both economical and practicable in many industries. Secondly, although less well known, the flame-softening process has now been given sufficient commercial application to indicate that it, too, has a definite place in the field of heat-treatment. And finally, flame-strengthening, the latest of the flame heat-treatments, gives every indication of still another important field of use for the oxy-acetylene flame as an industrial tool.

*See "Photoelastic Studies in Stress Concentration," M. M. Frocht, *Mechanical Engineering*, 58, 485 (1936).

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Bureau Of Yards and Docks

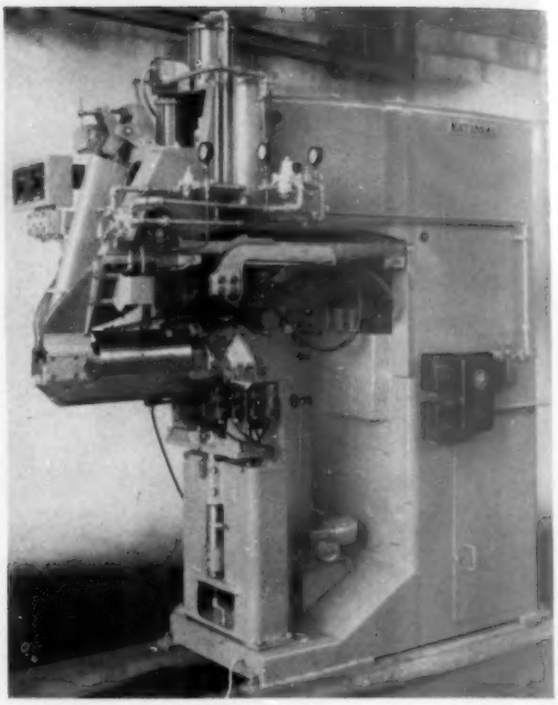
By COMMANDER C. A. TREXEL*

★ The Naval Shore Establishment includes navy yards, supply and fuel depots, ordnance and ammunition depots, submarine, destroyer and air bases, radio traffic and direction finder stations, marine barracks, naval hospitals, training stations, aircraft, gun and powder factories, research and experimental laboratories, etc. Obviously there are many structures at these various stations which utilize welding in their construction or repair. Hangars, shops, storehouses, bridges, piers, bulkheads, shipbuilding ways, radio towers, water and fuel tanks, boilers, piping, floating and bridge cranes, dry dock caissons and many others lend themselves readily to fabrication by welding. The author mentions and presents illustrations of a number of these structures.

Standards for both design and field inspection of welding are a definite need, and a prerequisite to general acceptance of welding in structural steel work. To enable it to adopt welding for important structures, the Bureau of Yards and Docks has prepared such standards which are in use on work under its jurisdiction. While the almost universal use of the shielded arc or coated electrode has gone far to establish dependability of welding, and visual inspection is generally accepted as a satisfactory method of determining the integrity of shop and field welds on structural work, there is need for a convenient, reliable and inexpensive non-destructive method of field testing of welds.

Standards for the qualification of welders, materials and processes, while of the greatest importance in maintaining a high standard of workmanship, need to be simplified, and costly requalification of welders for each new job eliminated. Welding designers are needed who are not only versed in the theory of design, but who are also thoroughly acquainted with the welding art, and shop and field practices. To a much greater degree than in riveted work is the economy and even the quality of work in the shop and field dependent upon the character of the designs prepared in the drafting room. By reducing the amount of field welding, by positioning in the flat or horizontal positions, and by providing convenient erection connections, the designer can effect substantial economies in field erection. Standard forms of connections and other details such as are available for riveted work, need to be developed for welded design, in order to reduce engineering costs and excessive time required to prepare welded designs.

*Bureau of Yards and Docks, Navy Department. Digested from an A.W.S. paper.



Automatic high production welding machine for seam welding paint pails. Spot welds are controlled by photo-electric cells. Photo (National Electric Welding Machines Co.).

Time-saving digests of selected A.W.S.

Resistance Welding Papers

★ The unusually large number of papers on this subject was a prominent feature of the recent annual meeting in Chicago

Latest Developments in Resistance Welding

By R. T. GILLETTE*

★ Welding controls vitally affect all welding methods. The electronic or vacuum tube control is the most consistent control now available for resistance welding. While its original cost may be higher than that of some other types of control, its lower electrode maintenance cost, noiseless operation, accuracy, flexibility, synchronous switching, and extremely low rejection of parts due to faulty welding, more than justify the difference in original cost. This control has been one of the most important factors in the development of a great many welding jobs that were formerly considered difficult or impossible.

Recent developments in spot welding equipment have made available motor driven, air or hydraulically-operated spot welders which are really machine tools. One important factor that has been recognized is the inertia of the moving element or head. If, in short time welding (½ cycle or less), the pressure follow-up is too slow, burned work and high electrode consumption will result. Consequently efforts are being made to keep the moving parts as light as possible, and still retain a sufficient amount of copper to carry current to the weld. Another advancement in spot welding was the introduction of multi-matic, speed-matic, hydro - matic or ultra - speed welders. This type of equipment, having as many as 150 spot welding points or stations, welds a complete assembly, while it is rigidly clamped in a fixture, thereby reducing distortion or misalignment to a minimum.

The interrupted method of spot welding was developed to overcome the electrode maintenance difficulties experienced in welding heavy materials (3/16 to 1 in.) with a continuous flow of current. This consists of bringing the electrodes in contact under pressure in the regular manner, and then applying current in a series of impulses rather than continuously. This interruption of current allows a welding temperature to be built up in the weld, without excessive heat in the electrodes or surface of work. It also gives much better heat distribution on heavy material, and allows time for good forging action on the weld.

Seam welding technique and equipment have developed rapidly in the last few months, particularly for jobs

*Resistance Welding Specialist, General Electric Co.

where large production and suitable design have permitted the use of multiple-wheel welders. This type of seam welder is adaptable to a great many types of work, especially jobs of large size, such as cabinets, refrigerator parts, and structures as large as railroad cars. The author explains in detail the operation of two welding machines used for this type of work, and also describes two rather unusual seam welding jobs that were carried out successfully. One of the latter was the welding of 0.020 in. low-carbon steel to 1, 2 and 4 in. materials of the same analysis; the other was the welding of two pieces of 3/8 in. material.

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Contact Resistance in Spot Welding

By F. J. STUDER*

★ The actual importance of contact resistance in the spot welding process has not proved to be easy to determine. This is because the characteristics of contact resistance under welding conditions have not been known. The opinion is often expressed that surface resistance is, in most cases, necessary for effective welding by this method, since it brings about the production of heat right at the boundary where welding occurs. On the other hand it has been the feeling of some that boundary resistance really plays a rather minor part in the welding process; that under conditions where it is high enough to be of any consequence, it produces too localized heating, which results in a very thin weld "nugget" of low strength. The present study was undertaken to determine the characteristics of contact resistance under circumstances that occur in spot welding, from which it should be possible to tell more about its action during the welding cycle.

The apparatus used in this investigation was designed to simulate the conditions found in the gap of a spot welder. Means were provided for passing a current through two specimens held in contact by evenly distributed pressure of variable magnitude. Specimens of several different types were studied, and the contact resistance under various conditions was determined by measuring the potential drop between the specimens. All experiments were conducted with a low current (1 to 20 amps.) passing through the samples. The set-up included an electric furnace which could be placed in a position surrounding the specimens, for making contact resistance measurements at temperatures up to 750 deg. C. The greater part of the work was done with low carbon and stainless steel sheet, of standard finishes.

These experiments verified the reports of previous investigators on the effect on contact resistance of area of overlap and size of electrode tips. It was found that the resistance was unaffected by the area of the electrodes which push the surfaces together, even with sheets of different thicknesses. It was observed also that contact resistance was for all practical purposes independent of the area of overlap of the surfaces, i. e., the variation from one area of overlap to a different one was no greater than the variation for a given area taken at different places on the surfaces.

A comparison between four standard factory finishes of steel revealed no indication of a difference in contact resistance characteristics. Sandblasted samples, however, showed a consistently lower resistance at any given pressure. It was observed that the contact resistance between ordinary surfaces was extremely variable. Carefully made duplicate tests frequently revealed values of approximately half or double the original value.

Numerous tests were made to demonstrate the effect of pressure on contact resistance, and curves were prepared to illustrate the trends for decreasing as well as increasing pressures. It was observed that for decreasing pressure the resistance did not increase until the pressure had been greatly reduced, and even at the lowest value of pressure the resistance returned to only a fraction of its original value. If it should be useful to make a weld with low initial contact resistance and low electrode pressure, this can be accomplished by applying a high pressure, and reducing it before the welding current is turned on. It was remarked that samples of the same material, with the same finish, may give pressure-resistance curves of quite different slopes on a log-log curve.

Direct measurements showed that in every test but one (aluminum alloy containing 4% copper in contact with cold-rolled steel), the contact resistance decreased rapidly with increasing temperature, and reached a very low value at relatively low temperatures, regardless of the pressure on the surfaces. Since the fall in the value of the resistance began at a temperature well below that at which the metal showed any tendency to soften, it was believed that the decrease in resistance was due to the driving off of a film of some kind from the surfaces of the specimens.

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Precision Welding by the Resistance Method

By G. J. OSWALD, E. J. BATES and R. L. HOUS*

★ In the manufacture of complicated precision machines, methods of joining parts together assume a very great importance. Space limitations require that joints be of minimum size, yet of maximum strength; assembly requirements are such that accuracy as close as 0.001 in. must be maintained; the very smallness of many of the parts introduces high stresses; and frequently there are repeated impacts to be resisted. It will be evident, therefore, that any improvment in joining methods which produces savings in space, which permits greater accuracy, or which results in stronger and more ductile joints, will be of immense importance to all manufacturers of such machines.

Many improvements in this field have recently been accomplished through the developments in equipment for spot and projection welding. Progress has been made particularly in controlling more accurately the variables of current, pressure, timing, and electrode alignment. These improvements, together with increased rigidity, have eliminated the nonuniformity unavoidable with manually-controlled equipment.

Our present practice in projection welding small, accurate assemblies was adopted after a thorough study of the effect of projection size on the properties of a weld. Such an investigation was required because ordinary projection welding practice is not applicable to small and very accurate parts, which require that there be practically no distortion and no loss of location in welding due to shifting, twisting, buckling, etc. The results of this study, in which a large number of welds were tested in shear and in torsion, showed that excellent results could be obtained

*Union College.

*All of National Cash Register Co.

through the use of low, accurate projections and precision-made fixtures for holding the parts in place. It was found that low projections (.008 to .010 in. in height) reduced the amount of pressure required to produce sound, strong welds, which in turn was a further aid in lessening distortion and shifting of parts in the fixture. In general, the current-time relationships which gave best results were those of relatively low current values and longer times, rather than those of high current values and short times.

The strength, ductility and uniformity of welds made with these lower, slightly wider projections are such that this type of projection may be placed on an entirely comparable basis with the higher projections generally used. This is especially true for small parts made from .025 to .125 in. stock, where welds of this type would not fail before the parts themselves were permanently deformed or destroyed.

Jigs and fixtures are used in resistance welding for the same purposes as in drilling, milling, and other machine tool operations. Only through their use is it possible to maintain extreme accuracies. The following rules are suggested for the guidance of the designer in working out details of resistance welding fixture construction: (1) keep all magnetic materials out of the "loop," and keep the "loop" as small as possible; (2) make all welding electrodes easily and quickly replaceable, and water cool them as close to the tip as possible; (3) insulate all gauge pins, clamps, locaters, index pins, etc.; (4) provide sufficient cross section to current-carrying members, run as close to the electrodes as possible, and use a minimum of connections in the circuit; (5) provide protection from flash for all moving slides, bearings, index pins, adjustable screws, and any accurate locating device; (6) provide adjustment for electrode wear; (7) check welding pressure application; (8) provide ease of operation and protection for the operator.

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Spot Welding of Automobile Grade Mild Steel

By W. F. HESS and R. A. WYANT*

★ The material tested was a low carbon steel, 0.036 in. in thickness, which had been prepared with a bright, smooth finish for deep-drawing operations. The principal objective was to establish the optimum spot welding conditions. Other objectives were to compare oily with degreased stock, to study the effects of varying electrode pressure dwell time and to make a preliminary study of performance of dome-shaped tips. A phase of study, which developed during the investigation, was the effect of variations in grain size.

Single spot lap welds were tested in tension. Welding currents and resistances were measured by means of an oscillograph. Photo-micrographs were obtained to illustrate and give evidence of the nature of several effects studied.

With ¼ in. flat tip electrodes, strength and indentation characteristics as functions of current are shown for unit electrode pressures of 10,000, 15,000 and 20,000 psi. at 6 and 12 cycles. For both time values an electrode pressure of 15,000 psi. gives best welds. Optimum currents are 12,500 and 11,000 amps. at 6 and 12 cycles respectively. Surface indentation was again found to be a sharp criterion of optimum current.

Characteristics of strength, indentation and weld diameter as functions of current are shown for 4-in. radius dome-shaped electrode tips at an electrode pressure of 750 lbs. for 6 cycles. These characteristics are compared with similar characteristics for welds made with ¼-in. flat tips. In this preliminary study of dome-shaped tips, several advantages over flat tips are apparent. Welds having only 5% less strength are produced with 10% less current. Also the strength-current characteristic is flatter. There is also an indication that a domed shape may lengthen the life of electrodes.

In comparing oily with degreased material only slight differences in strength were found. While these differences are about 3%, they do indicate a tendency by always favoring the clean material. Caution is advised if the oil contains foreign matter.

Time of electrode pressure dwell after cessation of current flow was found to have a critical value at which welds of somewhat lower strength were produced. For 12-cycle welds this value of time is about 4 cycles and the reduction in strength about 6%. When it was discovered that the steel varied in grain size, fine and coarse specimens were selected for comparison. The fine-grain steel gave welds which were 10% stronger.

*Both of Rensselaer Polytechnic Institute.

» «

Spot Welding of Low Carbon and Stainless Steels

By W. F. HESS and R. A. WYANT*

★ This investigation was a continuation of previous research work. The materials were hot rolled, annealed and pickled low carbon steel, 0.047 in. in thickness and 18-8 annealed stainless steel, 0.068 in. in thickness, in both the dull and polished finishes. The principal objective was to establish optimum spot welding conditions. Other objectives were to compare flat electrode tips of different diameters, to compare finishes on stainless steel and to obtain resistance data.

Single spot lap welds were tested in tension. Welding currents and resistances were measured by means of an oscillograph. Photo-micrographs were obtained to illustrate and give evidence of the nature of several effects studied.

For the mild steel, strength and indentation characteristics as functions of current are shown for ¼ in. flat tip electrodes used at unit pressures of 10,000, 15,000 and 20,000 psi. for both 6 and 12 cycles. For both time values, an electrode pressure of 15,000 psi. gives best welds. The optimum currents are 13,500 and 12,000 amps. at 6 and 12 cycles respectively. Similar characteristics are shown for 6-cycle welds made with 3/16 and 5/16 in. flat tip electrodes at a unit pressure of 15,000 psi. Optimum currents are 10,000 and 21,000 amps., for 3/16 and 5/16 in. tip respectively.

For stainless steel, strength and indentation characteristics as functions of current are shown for 6-cycle welds made in both the dull and polished finishes with 5/16 in. flat tip electrodes at a unit pressure of 50,000 psi. Comparative characteristics are shown for the polished finish material at 2, 4, 6 and 12 cycles.

Diameters of the best welds in mild steel approach very closely that of the electrode tips. In stainless steel the strongest welds are about 8% larger

*Both of Rensselaer Polytechnic Institute.

in diameter than the electrode tips. A basis for selection of the proper size of electrode tip for a given material is discussed.

Different types of distortion were found in welding the two materials at high currents and high pressures. The mechanism of this distortion is discussed and illustrated by photo-micrographs. Observations are also made of the types of failure encountered.

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Production Panel Welding of Railroad Cars

By JOHN W. SHEFFER*

★ The use of light gauge, low-alloy, high-tensile steel in modern railroad car construction has favored welding rather than riveting as the method of fabrication. Arc welding is being used for the underframe and heavier sections, and spot welding for attaching sheathing to the sides, ends, doors and roof. By breaking down the main assembly operations into numerous sub-assemblies, it has been possible to apply production methods and achieve greater uniformity. For example, the side frame structures of passenger cars, although they are not exact duplicates of each other, are enough alike to permit the use of a flexible jig for the construction of all of them. The same type of sub-assembly is used in the construction of the roof, end frames and underframe.

The keynote of recent developments in multiple spot welding equipment has been flexibility. Changes in design of products are being made continually; rapid advances are being made in welding technique; and new materials are constantly coming into use. Consequently, unless welding equipment is designed with adequate provision for flexibility, an expensive welding machine might become almost obsolete in a year or less. A good example of flexibility of application is a welder used for panel welding of passenger car sides, which can also be used with a different set-up for panel welding of roofs. Flexibility of operation is illustrated by an automatic panel welder which will: (1) permit manual control of each welding operation individually if desired, (2) permit a set-up to be made, which will then proceed automatically to the final pre-set point, (3) permit any previously pre-set set-up to be interrupted if desired, a single operation performed, and then continue the pre-set set-up, (4) permit manual termination of any individual operation.

A new development in multiple spot welding equipment, through the use of a multiple distributing switch in the secondary or heat generating circuit, permits the entire group of electrodes to be put under pressure simultaneously. These electrodes act as a self-contained clamp at each weld location, and remain in this position through the entire cycle of individual electrode welding sequence. With these facilities for applying the correct amount of pressure on all electrodes simultaously and having them dwell (without time delay) until the various welds are sufficiently cool, very clean, strong and uniform welds are produced.

*American Car & Foundry Co.

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Application of Portable Spot Welding

By C. E. HEITMAN*

★ Portable spot welders have many disadvantages as compared to stationary welding machines. They are usually quite heavy and cumbersome to manipulate, and the welding transformer, control equipment, supply lines and power equipment must be several times larger than for an equivalent stationary machine. On high-speed operations cable failures occur all too frequently, in spite of water cooling, causing a serious maintenance item. These disadvantages of portable spot welding are mentioned to emphasize the point that this method of spot welding is far from ideal, but born of necessity. It is a process which fills a need in industry, and although many of its applications are destined to be replaced by automatic multi-spot welding machines, it will continue to serve economically in many applications.

In its present form a portable spot welding unit consists of a portable welding gun, by means of which pressure is applied to the parts being welded, a welding transformer which may be stationary or movable, and which is electrically connected to the welding gun by means of flexible welding cables, and means for applying and timing the electric current to the transformer. Welding machines of this type can be divided into two classes: (1) those applied to production line fabrication where the unit is semi-portable, in that it forms a permanent part of that particular production line and is portable only in the sense that it is movable through a relatively short distance; (2) those applied to job shop fabrication wherein the quantity production of any one part does not justify a production line, and where one piece of equipment may see duty on many jobs in different parts of the shop in any one working day.

It is in the second classification mentioned above, namely the job shop, that portable spot welding has its greatest future. The very name "job shop" implies comparatively low production for any one design, where the cost of automatic machines can usually not be justified. It is in this field that portable spot welding is particularly applicable. Every equipment must, and can very easily be, somewhat of a general purpose machine. It is portable, as the name implies, and can be used on many different jobs in any part of the shop. This method finds wide-spread application in fabrication of railway cars and equipment as well as in construction of numerous products of stainless and mild steels.

The gauges of metal frequently welded vary from a minimum of two thicknesses of .004 in. to two thicknesses of 3/16 in. It is obviously impractical to cover this entire range of welding with one size of welding equipment, due to the wide range of welding currents necessary. Experience has shown that five different sizes of equipment, namely: 10, 25, 50, 100 and 200 kva. give the best economic balance, although on certain special jobs larger units are used. Naturally, the size and weight of various items of equipment vary with capacity of the unit, and gauge of metal to be welded dictates the size of unit to be used. The welding tools in common use vary from a small tool weighing 15 lbs. and developing 200 lbs. electrode pressure to a tool weighing 300 lbs. and developing 8000 lbs. electrode pressure, with many other intermediate sizes and designs. All are considered portable in that they are carried to the job, although of course it is necessary to support the larger ones by means of some balancing arrangement.

†Edward G. Budd Mfg. Co.

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One wing rail of this manganese frog has been ground out preparatory to welding. Defect extended all way through casting. Photo (Teleweld Inc.).

Welding procedure for high-manganese and

Nickel-Manganese Steels

★ Widespread adoption of welding repairs to manganese trackwork enables railroads to cut maintenance costs materially. Further research work is suggested

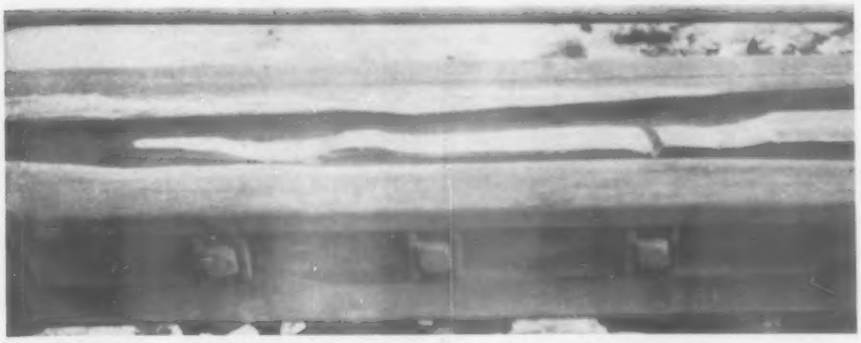
By C. M. MAGEE
Research Engineer, Association of American Railroads, Chicago, Ill.

MANGANESE STEEL (Hadfield's composition) has two important advantages for trackwork. First, it can be cast in the desired shape and thus trackwork can be made in one piece, affording economical maintenance. Second, it has the unusual physical property of increasing greatly in hardness under cold working, and yet it possesses good tensile strength and ductility. Thus it is able to resist the wheel impacts at the points.

The disadvantages of manganese steel for trackwork are its high first cost and (until the last few years) the inability to replace the battered points without replacing the entire casting. The development of a process for welding manganese castings has been valuable in railway work and it affords an interesting example of the application of welding to industrial problems. Until recent years it was generally conceded that welding of manganese could not be done. But today it is being done on an extensive scale.

Iron and manganese form a continuous series of solid solutions. High manganese steel if cast and cooled in air consists of austenitic grains with carbide separated out at the grain boundaries. This steel is hard and brittle. If, however, the casting is quenched from a suitable temperature the carbides do not have opportunity to separate out at the grain boundaries and an austenitic steel comparatively soft (about 180-200 Brinell) yet very ductile is obtained. This steel, however, if cold worked by pounding, as by car wheels, will build up to a hardness of 500-600 Brinell. The grains if examined under a microscope exhibit very peculiar "slip lines."

This high-manganese steel has no critical points, so that in heat treatment the operator has to be guided by the relation of the carbide separation to the physical properties. Experience has shown that the proper temperature for quenching is approximately 1850 deg. F. Frog castings after removal from the moulds and all casting protuberances taken off are reheated to this temperature in a furnace. Several hours are required to insure that all parts of the casting are brought to this temperature. The casting after properly heated is quenched in a circulated water bath. This rapid quench holds the carbide in solution and prevents the undesirable separation at the grain boundaries.



Profile of a manganese frog ground out ready for welding. Note the groove at right made necessary by presence of small crack in casting.

Since high-manganese steel depends for its desirable properties upon its heat treatment it is obvious where the difficulty in welding will lie. Earliest attempts at welding with high manganese welding rods produced a plane of weakness at the junction of weld and parent metal. Experiments have shown that high-manganese steel can be heated to approximately 700 deg. F. without detriment, but if heated to temperatures of 900 deg. F. or more the structure is very materially damaged. The plan naturally suggests itself of making the weld with high-manganese rod, followed by quenching the deposit with water. This was the first successful form of welding manganese in railway frog work. The weld was placed in rectangular pads, peened and quenched. This method gave fairly satisfactory results, but the welding cost was high.

3 to 5% Nickel

About 1926, it was discovered that the addition of 3-5 per cent nickel to the high-manganese rod would give an air-quenching rod. It is said that this discovery was an accident. It is known that nickel has the effect of lowering the transformation points in steel and can be used to produce air-quenching steels. Nickel seems to exert the same function in the high-manganese steel and in addition it is claimed, that in the welding procedure, the nickel in the weld deposit tends to permeate into the adjacent parent metal and avoid destruction of its properties by the heat effect.

The amount of research work which has been done on this subject is rather extensive and yet not entirely adequate. The American Electric Railway Engineering Association has published results of some interesting research work conducted several years ago. This work indicated that the grain structure in the transition zone between parent and weld metal, the regranulated structure, is better with the nickel-manganese weld. Some carbide separation occurred at the grain boundaries. The structure of the deposited nickel-manganese weld metal appeared somewhat different from the characteristic grain structure of quenched high-manganese steel.

Impact tests were made by dropping a 30 lb. weight through a distance of 5 ft. on specially prepared test cones. Two different groups of engineers made corresponding series of tests using coated high-manganese rod on one series and nickel-manganese rod on the other. Both interests reported essentially the same reduction in height, relative to the number of blows, for each type of welding rod and the Brinell hardness numbers were quite similar. One group reported that welds with both types of rods showed some horizontal cracking in the junction zone between weld and parent metal after 50 blows, with maximum enlargement after 100 blows and no enlargement after 200 blows. The other group reported that after 200 blows, the cones welded with high-manganese electrode showed cracks on the top surface radiating outward from the center like spokes of a wheel.

Finished weld on a No. 2 frog. Highly polished surface is shown white because of light reflection.

The service performance of nickel-manganese welds on high-manganese castings has been fairly satisfactory. Good results can be secured on frogs subject to low-speed traffic, particularly on crossings of nearly 90 deg. angle. Satisfactory welds on turnout frogs and small angle crossings subject to high speed and heavy traffic are difficult to make stand up.

Stainless Steel Base Layer

Some railroads have applied a base layer of stainless steel electrode, building up on this with nickel-manganese. I have experimented with this method with fairly good results, although I have not yet been able to ascertain that the results are in any way superior to building up with nickel-manganese. One experimental weld using stainless steel rod involved rebuilding of a foot length from one wing of a solid manganese crossing which had broken off. This crossing was subjected to slow-speed service, and is standing up well after more than two years of service.

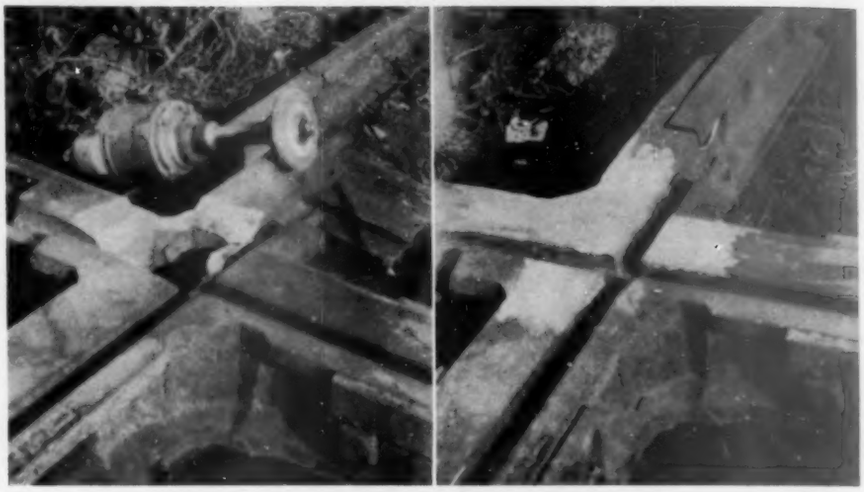
Further research work can be profitably done on the subject of welding manganese steel, concentrating primarily on improvements in method. Also, there have been certain recommendations made by trade interests to secure better service performance which are not based on extensive research and which increase the welding cost considerably. Some points which might well be determined are:

1. Effect of flame cutting before arc welding.
2. Effect of welding with frogs at high and at low atmospheric temperatures.
3. Effect of various amounts of peening.
4. Relative results with coated and uncoated rods.
5. Welding on nickel-manganese compared with welding on high-manganese castings.
6. Welding with stainless steel base layers.

For most economical use of welding on manganese trackwork it is essential that a systematic program be inaugurated, whereby frogs will be rebuilt before the batter and resultant impact

Welding of Manganese Steel

Manganese steel, because of its hardness and toughness, is being used more extensively in railway track work. An outstanding advantage of manganese steel is its work-hardening properties and this is what makes it so well adapted to track work. In the welding of managanese steel some users claim that bare rods containing 3 to 5 per cent nickel are preferable to coated rods containing a similar combination of elements in the coating. This is a controversial point and for this reason we have included comments from several welding engineers. The author refers to tests recently made relating to the use of stainless steel electrodes to build a base layer, before building up with nickel-manganese. He suggests some of the technical problems which need further research, one of them being the determination of comparative results with coated and uncoated rods. Another reseach problem pointed out is welding of nickel-manganese as compared to welding of high-manganese.



(Left) One corner of a crossing ground clear through a sand spot in corner. First step in repair is to "tack" in 1 in. applicator bars. (Right) The finished repair. Note that the receiving points opposite have also been repaired. Built up with nickel-manganese.

attains considerable proportions. Such a plan has three important advantages: (1) It keeps the cost of welding repair within reasonable limits. (2) It keeps impact on equipment at a minimum. (3) It lengthens the life, and reduces maintenance cost of the frog by keeping impact low. On moderate traffic lines trackwork should generally be rebuilt by welding each year, and in some locations as often as every six months.

» «

Advocates Use of ¼-in. Bare Electrode

★ T. L. Borman, manager of the Frog and Switch Division of Teleweld, Inc., Chicago, has given us the benefit of his extended experience in welding of manganese trackwork. This company is said to be the largest welding contractor serving the steam railroads of the United States and Canada. Mr. Borman advocates the use of a bare nickel-manganese electrode. No water quench is needed. Most of this welding is done with ¼-in. electrodes using 175-180 amp. On some work a 3/16-in. rod is used with 150-160 amp. It is the practice to peen each bead while it is still hot. This is for purpose of stress relief and overcomes the tendency of the weld metal to check. Mr. Borman states that when doing this work in a strong wind, it may be better to use a lightly coated electrode, because it will put a little more heat into the manganese casting. Otherwise, however, it is bad practice to use coated rods, because they heat up the casting more than is necessary.

In repairing frogs and crossings which are badly damaged, such as illustrated in the photographs shown, Teleweld makes use of nickel-manganese applicator bars, ranging in sizes from ⅜-in. to 1-in. in diameter. After the defective metal has been ground out, leaving an opening in the casting, the applicator bars are inserted underneath the opening and tack welded in place. The operator then places weld metal across the area, using a semi-circular weaving motion, the width of the bead being approximately ¾-in. After the surface has been built up to proper size, it is necessary to grind to a smooth finish. These highly polished surfaces show up in the photographs as though they were painted white, but this is due to the high degree of light reflection from the polished surface.

» «

Advocates Using Flux-Coated Nickel-Manganese Rod

★ Russell E. Long, chief engineer of Hollup Corp., Chicago, believes that a lightly coated nickel-manganese electrode is best for welding manganese trackwork. "A heavily-coated rod would be detrimental," says Mr. Long, "because it would completely shield the arc and prohibit its fast cooling." High manganese (10 to 14 per cent) steel is austenitic and gets its maximum physical properties from its fast rate of cooling. If this electrode is shielded by the use of the common method of heavy coating, the arc heat is considerably raised which is very detrimental. A heavy coating also retards the rate of cooling by formation of slag on the surface.

We also find it advantageous to lay down small pads, not to exceed 3 in. in length and not over ¾ in. in width, and lightly peening them to compensate for the shrinkage, therefore, eliminating the cracks. This peening should be done at a relatively high temperature. If the operator has to stop to remove slag the weld deposit will be too cool to peen.

The coating on our No. 9 electrode consists of arc stabilizers and materials which will protect the passage of the molten metal by producing metallic gases around the arc stream. The deposited metal from our electrode is extremely free from all porosity and cracks and possesses physical properties equal to that of nickel-manganese castings.

» «

Chicago Surface Lines Uses Coated High-Manganese Rod

★ Jonathan Wolfe, assistant superintendent of track and roadway, Chicago Surface Lines, is an advocate of the straight high-manganese coated electrode, using a water quench, for welding manganese trackwork. Chicago Surface Lines is saving about $250,000 annually through a program of welding manganese castings to prolong their service life. This traction system has over 27,000 manganese castings in trackwork. These castings cost an average of 35c a lb., thus it is quite evident that welding for the purpose of prolonging the life of such castings is a very economical maintenance process.

In the 110 miles of single track operated by the Chicago Surface Lines,

there are more than 2700 layouts of special trackwork, including 17,000 frog points, 8700 switch pieces, and about 1000 cast pieces, such as bridge castings and compromise rails. It is conservatively estimated that welding of manganese trackwork adds two years to its service life.

Mr. Wolfe states that his experience with the use of high-manganese coated electrodes began in July, 1921, and has continued uninterruptedly since that time. The nickel-manganese electrode has been used on an experimental basis, but Mr. Wolfe firmly believes that better results are obtained with the straight manganese rod. Welding is done with the metallic arc, using ¼ in. lightly coated rod and a current of 150 to 160 amp. Small pads, one or two square inches in area, are applied, then immediately quenched with cold water and peened while still very hot. The peening breaks the light slag coating and mechanically stress-relieves the weld metal. At the present time over 3000 lbs. of manganese rods are used monthly in carrying out this welding program on trackwork.

The first attempt to weld manganese trackwork on Chicago Surface Lines was in 1912, but the results were generally not satisfactory and welding was resorted to as an emergency tool only. The casting was replaced just as soon as delivery could be obtained. Difficulty was experienced because of the peculiar nature of high-manganese steel. It was found that in the heat-affected zone surrounding the weld, the casting became very brittle, causing the weld to break out and making a much larger hole than existed before the welding repair.

» «

Telephone Advertising Will Get Welding Jobs

By H. R. SIMPSON

★ The local telephone directory is one advertising medium which should be marked "must" on the welding shop's list. Customers often require emergency service, or find themselves in situations calling for inquiry. Many of them will turn to the classified pages of the local phone book. That welding shops find the medium decidedly productive on the basis of cost is proved by the large number of welders who, twice a year, continue to repeat their advertising. Telephone directory advertising is like all other forms; there are right and wrong ways to use it. Here are several suggestions based on a recent study of directory advertising.

Besides the "Boilers" classification in the San Antonio, Texas, directory, the Alamo Welding Co., 812 No. Flores, ran a two-inch, single-column advertisement, with the single word in large, bold letters, followed by, "—Repaired and Manufactured in Compliance with New State Boiler Code." The shop management knew that, because of the new code, many people would be referring to the "Boilers" classification. Naturally, an advertisement with specific reference to the code would stand maximum chance of bringing results.

The practice of live-wire welding shops is to include night and holiday, as well as regular telephone numbers, in their directory messages. Remember that a high percentage of business produced by directories is from people who want urgent, rapid service. Circumstances may require that contact with the welder be made at night, on Sundays, or a holiday. Between two welding shops, one of which lists simply a day phone, while the other lists complete phone service, the latter is likely to get the call when a customer turns to the yellow pages at 9:30 pm.

G. C. (Shorty) Mueller, Phoenix, Ariz., includes in his copy the line, "Oldest Shop in Phoenix—Established 1919." Directory advertising should be brief; buyers are in a hurry. Yet some thought should be given to the competitive angle, and the inquirer is interested in facts establishing the qualifications of a shop. That "Shorty" Mueller has been established since 1919 in Phoenix spoke for itself. People believe that only efficient business enterprises survive. Age is taken as nearly complete proof of ability and square dealing.

Arizona Welding Works, also of Phoenix, in single column by two-inch space, run this: "Welders of Heavy Machinery for Mines, Crushing Plants, Contractors, Machine Shops. Boilers Any Size. Complete Portable Equipment." An "action shot" of a welding job in progress illustrated the advertisement.

Get a "Good" Number

Mighty helpful in directory advertising is a good telephone number. That means one which is easily remembered, which the inquirer can carry in his head without difficulty, as he turns from directory to telephone. It continues to be surprising how many welding shops are content with "any old" number which happens to be assigned them.

Riverside Boiler and Welding Co., 413 Burk Burnett Road, Wichita Falls, Texas, has a good number. So we find featured in their directory advertising, in some of the most prominent lettering of the message, "Call 7400." Low numbers, even hundreds, repeated digits (as 1111), successions (123), are some of the better types of advertising phone numbers.

It is no trick at all to find welding shop directory advertisements in which the telephone number is in small type. It should be one of the most prominent things in the advertisement. A heading, "Call 876 For Fast, Expert, Welding Service," in large type, with only meager amplification of name, address, and qualifications, is almost sure to be a successful message. There are a number of ways to emphasize the number. It may be repeated twice, or oftener. It may be made into a reverse plate, the lettering then appearing as white against a black field. It may be worked into the signature cut, or an original border. Be sure to emphasize the telephone number.

While copy should be kept down to comparatively few words, it is usually possible to include a number of selling statements, which will add to effectiveness. The market for a welding shop is a highly individualized market, varying with the territory served. Logically, there should be some specific appeal to the types of

customers most likely to consult the directory.

When a welder feels that he cannot afford display advertising space, it is still possible for him to use a special listing. For example, a single sentence of eight or ten words may follow his name, address and phone number. In the regular alphabetical listings, he may use a half-inch of space. The simplest advertising treatment is to buy listing in bold-face capitals. The reader, naturally, is inclined to feel that the firms thus featured are the more important ones.

However, a welding shop will find in a great majority of cases, that it can afford to use some display space. No welder would try to do business without a sign over his business premises. Of course not. He wouldn't try to get along without a telephone. Directory advertising is equally logical, its cost being considered in relation to potential business volume reasonably to be expected in the territory.

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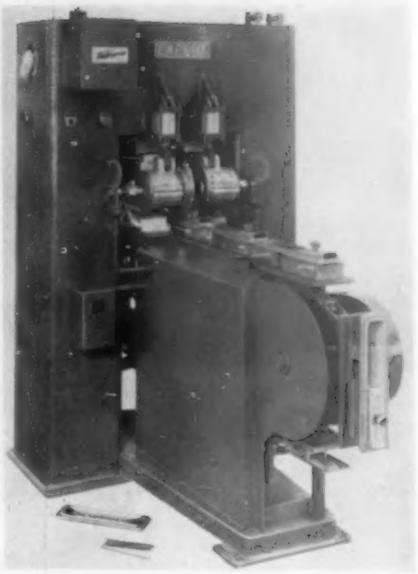
Making Spot Welds With a Seam Welder



Interrupting weld timer enables continuous seamwelder to spot-weld oil baffle plate to valve cover plate. Photo (Weltronic Corp.).

★ Continuous automatic spot welding, using a seam-welder, is an innovation recently placed in operation in a motor plant. The operation is made possible largely by the adaptation to a seam-welder of a standard Weltronic weld-timer which accurately controls length of time current is on and off, and provides an automatic repeating cycle.

Designed and built by Expert Welding Machine Co., Detroit, Mich., the machine is not only able to make accurately spaced spots, but also by means of an adjustable timer control is enabled to adjust the size (length) of spots to the exact amount desired, irrespective of production rate.

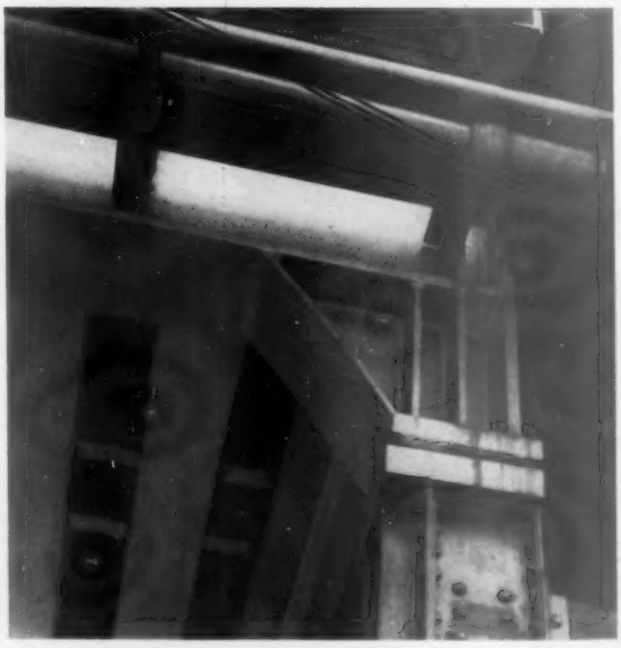
Designed for the purpose of series spot welding 19 gage oil baffle plates to 18 gage valve cover plates for both six and eight-cylinder cars, the new welder includes a conveyor for carrying the work under the seam rolls, a 50-kva. transformer, timer, contactor, etc., and is thus completely self contained.

The motor-driven conveyor carries 10 short-circuiting dies on which are placed either 18 or 12-in. valve cover plates (for eights and sixes respectively). The baffle plate is placed on top of the cover plate and the two are located and held in correct relative position by means of a stud with a bayonet fitting (for quick loading and unloading).

As the conveyor carries a loaded die under the rolls, a cam on the side of the die trips an air valve. This admits air into the pressure cylinders that bring the rolls into contact with the work. A limit switch automatically starts the timer. Immediately after the last spot is completed, the cam on the side of the moving die releases the pressure switch, cutting the timer and raising the rolls from the work.

The timer carries dial controls for setting "current on" and "current off" time—both adjustable in 1-cycle steps from 1 to 30 cycles of current. This permits accurate control of length and spacing of spots. Interruptions repeat automatically as long as the pilot switch controlled by the cam on the moving die is in the "on" position.

Although designed for a production speed of 450 pieces per hour, the machine is readily adjustable to suit any speed needed in relation to flow of parts in production. It thus eliminates the necessity for storage of either finished or unfinished work at the machine—parts being welded at the same rate as supplied. Change in conveyor speed is quickly compensated for by changing the dial setting on the timer, thus retaining the same length and spacing of spots irrespective of production rate.



Girder bearing brackets on bridge columns are of welded design. Reconstruction of the girder span entailed only 5 hr. interruption of railroad traffic. Photo (Wilson Welder & Metals Co., Inc.).

Fig. 1.—Hard-faced dipper tooth for a quarry shovel. Ferrous alloy used because of resistance to impact.

Analysis of
fundamental factors

Hard-Facing Technique

★ Part 1—Welded overlays give a composite structure possessing best combination of physical properties—Classification of hard-facing materials into well-defined groups

By T. B. JEFFERSON

Engineer, Marine Design Section, Chief of Engineers, War Department, Washington, D. C.

THE INCREASED DEMAND for welding has resulted in many new problems in the shop. One of these problems which at times has proved to be quite baffling has been brought about by the demand for hard facing to reduce wear. In every industry—mining, milling, dredging, quarrying, contracting, in the oil fields—in fact, wherever mechanical equipment is in use there are conditions of service which are destructive to the metallic parts of machines.

These havoc-wrecking forces may be one or a combination of the following:

Abrasion—that grinding action caused by abrasive solids sliding, rolling and rubbing against the surface of wearing metal.

Corrosion—the result of oxidation and other chemical actions to which metallic parts are subjected by the action of liquids and heat.

Erosion—the scouring action of liquids, vapors and gases traveling at high velocities on the wearing surface of a metal.

Galling—the adhesion or cohesion of localized areas of two bearing surfaces of metal followed by the tearing out of small fragments from one or the other of the bearing surfaces.

Impact—those light or heavy blows which tend to deform the surface of

Fig. 2—Two dredge pump liners (6 ft. 6 in. diameter). One shown in foreground has been protected with a non-ferrous corrosion-resistant overlay.

the wearing metal and result in the cracking and chipping of that surface.

It is impossible to determine the amount that is yearly added to the cost of industrial operations by the action of these destructive agents. Some twelve years ago, Sir Robert Hadfield, the famous steel maker of Sheffield, estimated that corrosion alone was taking a yearly toll of over three and one-half billion dollars from industry.

Realizing the magnitude of the expense incurred by the continual wear to which machine parts are subjected, industry has developed and adopted means of retarding wear. One of these means of particular interest today is hard-facing. However, many shops unable to master this means have avoided hard-facing jobs and have thereby passed up some very profitable business.

Hard facing may be defined as a process of overlaying by welding a metal with high hardness characteristics on a metal of lesser hardness, so that the surface of the softer base metal which is normally subjected to the greatest wear will assume the characteristics of the harder metal.

This process has been known to not only increase the efficiency of the part so treated but has prolonged its life by increasing its wear-resistant quality.

Most of the hard-facing manufacturers produce materials that are suitable for application by any of the more common welding processes, i.e., metallic arc, carbon arc or oxy-acetylene. However, some salesmen when mentioning the hard-facing products of their company immediately become electrified with mystery. One is led instantly to believe that the results produced by their products are magical if not miraculous. There is in reality very little of a mysterious nature concerning hard-facing materials. It is believed that much of the difficulty encountered in hard-facing applications is due to the failure of both the operator and the customer to understand a few of the basic metallurgical and physical characteristics of hard-facing materials.

For the purpose of identification all of the present day hard-facing materials may be classified into groups. Some authorities classify these materials in three groups, others four groups, while another school of thought calls for five groups of hard-facing materials. It is believed that for the purpose of simplification it will suffice to classify hard-facing materials in one of the three following groups: (1) Ferrous Alloy; (2) Non-Ferrous Alloy and (3) Diamond Substitute groups.

1. The Ferrous Alloy Group—This group is comprised of welding rods for hard-facing, having an iron base and alloyed with chromium, manganese, molybdenum, nickel, zirconium, boron and silicon. This group may be more closely classified by subdividing it into: (a) Those alloys containing less than 20% alloying elements, and (b) those alloys containing more than 20% of the alloying elements. The materials of this group range in hardness from 414 Brinell to 653 Brinell. Some of the hard-facing rods of this group will retain their hardness at high temperatures.

2. The Non-Ferrous Alloy Group—This group consists of welding rods for hard facing which are alloys of chromium, tungsten, cobalt and molybdenum and sometimes containing small quantities of iron. The quantities of iron are so small as to have no effect upon the non-magnetic properties of the rods. The hardness of this group at room temperature is about the same as that of the ferrous alloy materials. The non-ferrous alloys have a tendency, however, to retain much of their hardness at high temperatures. This quality is known as 'red-hardness.'

3. The Diamond Substitute Group—this group, which is composed of carbides of tungsten, tantalum, titanium and boron and the borides of chromium, is so called because its hard facing materials approach the hardness of the diamond. These materials are among the hardest available to man, ranging between 8.5 and 9.5 on the Moh scale of hardness. The diamond is given a hardness number of 10 on the same scale. The high melting point of the diamond substitute materials make it impossible to apply them by self-fusion; they must be bonded to the base metal by some lower melting alloy. Inasmuch as diamond substitute materials are furnished for two distinct methods of bonding this group is also subdivided into two classifications: (1) The rod and powdered forms, and (b) the insert form.

In the rod form the diamond substitute particles are either enclosed in an alloy steel tube or uniformly distributed in a cast alloy rod. In this form the diamond substitute particles are deposited in a manner similar to that used in applying any welding rod.

Powdered Form

The powdered form is manufactured in several styles; the most common of these is in the form of a powder in which case the minutely crushed particles are deposited by sprinkling them over the base metal. In another form the powdered particles are mixed in a paste and spread on the base metal. In either case the base metal is heated to its melting temperature thus allowing the diamond substitute particles, because of their greater density, to sink below the surface of the molten base metal and become firmly embedded.

The diamond substitute inserts are cast in a desired shape. They are deposited by setting them on the surface in which they are to be embedded after which they are "puddled" or welded in place.

Metallurgically, the deposits of the ferrous alloy rods may be either of a martensitic or austenitic nature or a combination of both. Martensitic deposits will exhibit their full hardness in their initial deposited state; that is, their hardness shows little or no increase upon cold working. The higher the hardness of a martensitic deposit the greater is its ability to resist abrasion, erosion, galling and the lesser its

resistance to impact. Austenitic deposits are generally referred to as self-hardening. These deposits differ from martensitic deposits in that they are relatively soft in the "as deposited" state and have the property of hardening at the surface when deformation takes place in cold working. During this surface hardening process the rest of the deposit remains relatively soft; consequently, an austenitic deposit is suitable for resisting impact wear.

The deposits of the non-ferrous alloy hard-facing materials are martensitic in that they produce their maximum hardness in their initial deposited state.

The diamond substitute materials are deposited as a matrix overlay; a deposit that is distinctly different when compared to those previously mentioned. This matrix is made up of small, extremely martensitic diamond substitute particles which are firmly embedded in a binder material of either an austenitic or a martensitic structure.

In selecting a hard facing material for the best results on a particular application the following table should be of assistance:

Table 1—Relative Deposit Characteristics of Hard-Facing Material

Deposit Desired	Material Group Number				
Abrasion Resistant	3b	3a	1b	2	1a
Corrosion Resistant	2	1b	1a	3a	3b
Erosion Resistant	3b	3a	1b	2	1a
Resistance to Galling	3a	3b	2	1b	1a
Resistance to Impact	1a	1b	2	3b	3a
Smooth	2	1a	1b	3b	3a
Hard	3b	3a	1b	2	1a
Thin	2	1b	1a	3b	3a

It may be determined from Table 1, that the deposits of the hard-facing materials of the ferrous alloy group are best for resisting impact wear; this is particularly true of those of low-alloy content. The low alloy materials will also produce a fairly smooth deposit. Those hard-facing materials of the ferrous alloy group with the higher alloy content are capable of producing thin and extremely hard deposits that will have good resistance to abrasion, corrosion, erosion and impact.

In Fig. 1 there is pictured a typical application of a ferrous alloy deposit. It may be seen that all of the surfaces of this shovel tooth have been protected by a hard-facing deposit. Since this tooth is to be used on the dipper of a quarry shovel, a hard-facing material from group 1a was selected for the protective overlay. This type of material was selected because of its excellence in resisting impact wear, a condition to which the tooth is continually subjected in quarry work. If this tooth was to be used in connection with the excavation of sand and gravel a ferrous alloy of group 1b would have been applied in the same manner. The use of the higher alloy content ferrous hard-facing material would give the tooth a wearing surface that would be capable of resisting the abrasive action of sharp particles of sand and gravel as well as capable of withstanding occasional impacts in such service.

Fig. 3—A 36 in. diameter core drill barrel with cutting edge hard-faced with a "diamond substitute" material. Roughness of deposit is an advantage on drilling and cutting tools.

Non-Ferrous Alloys

The thin, smooth, corrosion-resistant properties of the non-ferrous hard-facing materials make them ideal for protecting the parts of sewage pumps and other equipment that are exposed to acids and other corrosive conditions. In Fig. 2 there is pictured two 6 ft. 6 in. diameter dredge pump liners; the liner in the foreground has been protected by a hard-facing overlay while in the background is a new liner awaiting such protection. These liners by the nature of their service must have a comparatively smooth surface to prevent erosive wear conditions and a surface that is corrosion resistant. Since these liners were machined "full" without provisions for a hard-facing overlay, the deposit must also be thin. Table 1 indicates that group 2 materials will produce the thinnest, smoothest and most highly-corrosion-resistant deposit.

The diamond substitute materials are the hardest of all of the hard-facing materials and have the greatest resistance to abrasion, erosion and galling. Their deposits, however, are the roughest as well, a quality that tends to restrict their uses on many possible applications. This inherent roughness does have its advantages though, particularly on drilling and cutting tools as is shown in Fig. 3. In this application the group 3a deposit not only protects the cutting edge of this 36 in. diameter core drill barrel, but also provides the cutting edge with a rough abrasive surface which greatly increases its cutting effectiveness. This drill barrell is now capable of cutting hard limestone.

When due consideration is given to the metallurgy of the various hard-surfacing materials it can be seen that their metallurgical characteristics are the fundamentals of hard-facing and unless these fundamentals are understood an unsatisfactory hard-facing may be the result.

The next article in this series will discuss the hardness to be obtained from hard-facing materials deposited by the various welding processes.

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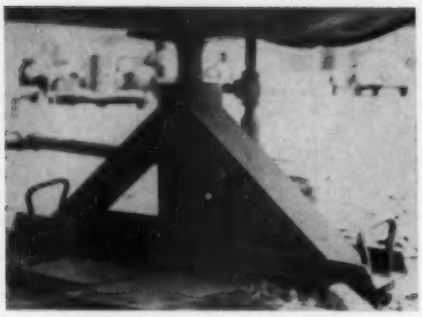
$200,000 Industrial Progress Award Program

A 2½-year program of scientific study, which will culminate in payment of $200,000 in awards, and which should produce widespread social and industrial benefits, has been announced by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. A total of 458 awards are established for studies bringing out benefits of a social, economic or commercial nature, such as reduction or elimination of hazards to safety and health, greater availability of comforts and conveniences through reduced prices, greater utility and durability of machines.

All inquiries concerning the $200,000 Industrial Progress Award Program should be addressed: Secretary, The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. Further details will be included in the January, 1940 issue of The Welding Engineer.

Brief Sketches of Welding Jobs



Welded footing for boiler front-end jack provides more stable support.

Welding Extends Jack Footing

★ The use of screw jacks, similar to those favored by house movers, for supporting the front ends of oil field boilers is widespread. Objection to the jacks is the relatively small footing afforded, requiring frequent adjustment to maintain direct support of the boiler smoke-box end. By welding sections of standard channel and a short stub of six-inch pipe around the square-thread nut section of one of these jacks, the welder for one drilling contractor has built a jack with greatly extended footing. This design resists any side sway of the load.

The nut is welded into the top of the pipe section—this work being done with all but a small segment of the nut under water to minimize possible distortion of the thread. The pipe is centered in a four-foot length of eight-inch channel. Angle braces are formed from six-inch channel, welded near the ends of the horizontal base, and close to the top of the thread-supporting pipe.

When thus surrounded by pipe and channel housing, the jack screw is completely enclosed, and protected from accidental damage and also from dirt, grit or other material. Handles, formed from ⅞-in. rod, are welded to the base channel at the ends of the braces, and provide for easy handling of the jack.

» «

Welding Increases Seating Capacity at Ball Park

★ Increasing the capacity of Crosley Field, home grounds of the Cincinnati "Reds," in time for the World Series, and without any interruption to play, was made possible by means of arc welding.

The arc welding process permits fast steel erection without use of auxiliary connecting members. Because of its silent operation there was no noise interference to players nor spectators. Knowledge of this advantage prompted the management of the Cincinnati "Reds" to employ the arc welding process to increase the seating capacity of Crosley Field. Shielded arc welding equipment, supplied by The Lincoln Electric Co., Cleveland, Ohio, was used.

Seating capacity was increased by 3100, providing accommodations for 31,600. The work, involving a new grandstand section in both right and left fields, required 400 tons of steel. The original roof on each of the pavilions was removed, the new second deck erected, and then the original roof was replaced over the second deck. Arc welding was used to join all seating decks, to weld all steps, runways and platforms, and join the new decking and columns to the grandstand proper.

Speed of steel erection by arc welding is indicated by the comparatively short time of 20 days required for the Crosley job.

Modern "steel carpenter" welds seat decks. Photo (Lincoln Electric Co.).

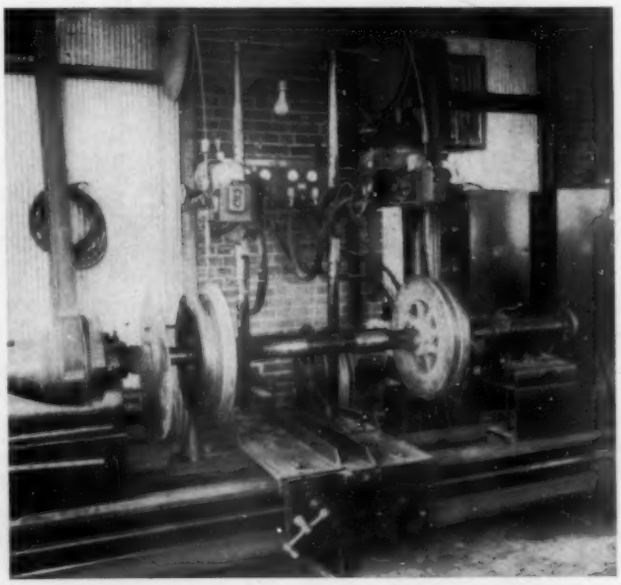
» «

Mine Locomotive Tires Rebuilt by Arc Welding

★ Mine 43 of the Peabody Coal Co. in Illinois has welded up a total of 1376 worn mine locomotive tires with a breakage of only 11 units. Since the development of improved welding practices there has been no breakage whatever. This coal company has had many years of experience in repairing steel tires. This experience has led to a method which apparently eliminates the uncertainty of results.

Several elements figure in the successful process. First, the worn-out tire is preheated. Then, during the welding procedure, a continuous motor-operated peening hammer is directed on the new bead, while the wheel is slowly cooling in an insulated base. Among the equipment used are General Electric arc-welding sets together with automatic heads, cables, reels, torch, peening unit, and geared-down welding lathe.

Since in most cases the deposited material is softer than the original tire, the repaired tire actually has more traction than when new. This, however, is dependent upon the type of electrode used. A hard surface may be put on if that seems preferable. Since



Automatic arc welding set-up for rebuilding tires of mine locomotive. Photo (General Electric Co.).

many varying factors are involved in determining the cost of such a repair job under different conditions, it is difficult to determine the exact expense per wheel. The figure of $11 per tire, however, has been given as the over-all cost for such a job.

» «

Arc Welded Catamaran For Navigating Shallow Waters

★ Arc welding has made possible one of the world's queerest water craft. Technically a catamaran, the 40-ft. craft shown in Fig. 1, consists of two steel pontoons 42 in. in diameter and a welded superstructure. Lap, butt and fillet welding was employed save for a few hinge rod joints and less than half a dozen bolts. But the catamaran, already christened the "Empress of Oakland," by the Oakland Chamber of Commerce, is in its component parts a 100% welded craft.

Weighing approximately 10,000 lbs. and constructed at a cost of $7,500 by S. H. Bullock, welding engineer, and John Thoman, Jr., and associates, the craft has a capacity of 25 passengers. It will be used as an excursion boat and for private fishing trips. The deck, 4 ft. wide, runs along both sides 32 ft. from the rear, and across the rear end 18 ft.

Each pontoon is 39 ft. 6 in. long and 42 in. in diameter except for the forward end, which tapers down to a 6-in. blunt point, the lower side having a sharper angle to cause it to glide or "lift" over rough water. Black 10-gauge sheet steel is used for skin construction and interior compartment dividers, except for the forward ends which are of 12-gauge. In case of collision, the lighter ends, 6 ft. in length, will break down and absorb the shock, leaving the rear air compartments undamaged. Every 6 ft. there is a welded-in bulkhead. This space is again quartered by four plates welded in, making four air-tight compartments in each space; 24 on each side. The aft end of each pontoon houses a 100-hp. marine type six-cylinder engine, vacuum clutch connected to the bronze propeller, the shaft of which extends from the lower end of the pontoon.

Main cross members between pontoons are 6-in. pipe; lateral floor supporting members are 4-in. pipe. Along both sides, top and bottom of each pontoon are 39-ft. pieces of 4-in. angle iron, open side against the surface steel over the internal contact point of compartment dividers. Welded at both edges and ends closed by triangular pieces set at an angle, these furnish pontoon rigidity and act as "buffers" or bumpers, protecting the craft in case of contact with a dock or other craft.

The somewhat "snubby" nose is welded up of sections and the interior of the pilot house was fabricated by sheet and structural welding, even to panels for instruments, shelving and doors. Cleats, instead of the usual cast type, were made by welding a 15-in. piece of 1¼-in. steel rod parallel to a 6-in. piece and the latter to the deck. These are for holding ropes, especially when the boat ties up at a dock. The deck hand rail is of 1-in. pipe welded at all joints. The craft has a draft with normal loading of 18 in. and a displacement calculation indicates that 210 tons would have to be applied to submerge the pontoons to their full depth.

Cabin, pilot house and motor compartment ventilators are of sheet steel welded to form and in turn welded to the boat. Forced down draft ducts of welded steel cool the motors. Welded rods from all controls, which are located in the pilot house, run through welded pipe conduits under the deck floors to motors and rudders. Rudders are sheet steel welded to the shafts. Loss of one or both rudders would not lose control, since the motors operate independently. One operating in "reverse" against the opposed one in "forward" would turn the craft within its own length.

This unique water craft was built in the shops of Haines Machinery Co., Oakland, Calif.

» «

A Profitable Job for the Welding Shop

★ Elmer Thies, proprietor of the Thies Welding Co., Fredonia, N. Y., recently called our attention to a profitable job which may not be known to the average welding shop.

From time to time aluminum cylinder heads come in to his shop to be repaired. The heads become so badly pitted around the stud holes and water circulating ports that water leaks past the gasket. Mr. Thies takes the heads and cleans the pitted spots by grinding. After slightly preheating the head at the point where he intends to weld, he repairs the pitted spots using 5/32-in. "Aluminweld" electrodes, supplied by The Lincoln Electric Co. After the welding, he files the repaired spots down to a true surface so that the head gasket gives a tight seal.

Only 10 to 15 min. is required for the average job, including cleaning the work, preheating, welding and filing. The charge is $1.50.

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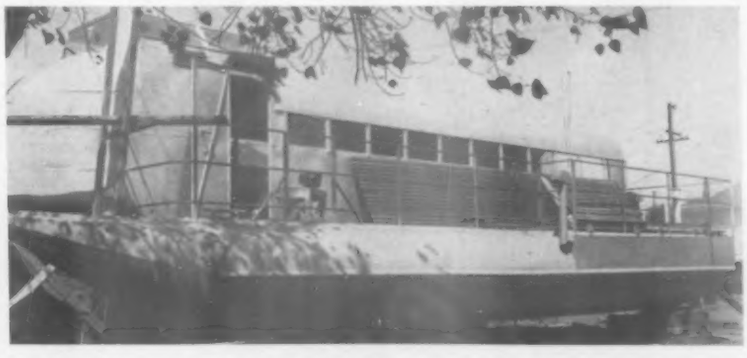


This freakish looking craft is technically a "catamaran." It is essentially an all-welded job. Photo (E. R. Cline).

Arc welding the twisted conveyor worm "flight" to the solid steel shaft. Photo (General Electric Co.).

Arc Welding Makes Better Coal Conveyor Worm

★ Arc welding enables the Iron Fireman Mfg. Co., Cleveland, Ohio, to produce a more efficient and longer-lived coal conveyor worm for use in its domestic, commercial and industrial stokers. Shown here is an operator welding cold rolled and twisted conveyor worm flights to solid steel cores. This process is more flexible than the steel casting operation previously used. It produces a uniformly true worm, and permits the use of flights of two thicknesses on the same worm, for greater stoker efficiency. This feature cuts down wear and adds materially to the life of the worm.

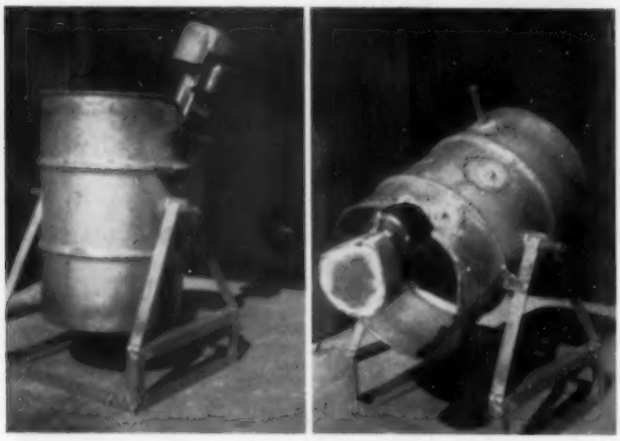
It also makes possible the use of special alloy steel flights on the tip end of the conveyor worm. These flights resist wear and corrosion, resulting in longer life.

» «

Oil Drums Converted Into Lime Slacking Vats

★ Good use was made of 55-gal. oil drums in the fabrication of a number of lime slackers, by American Steel Contractors, Berkeley, Calif. These drums are a good size for the purpose, and are quickly prepared by cutting out the top and welding up the opening.

The bases shown in the illustrations are made of 2 in. x 2 in. x ⅛-in. angle iron, flame cut and arc welded; and bearings for the shaft are formed from 5/16 in. x 2-in. iron. Shafts are cut from 1-in. pipe and welded to the drum. These are set so that the center of gravity is low enough when the device is charged, to keep the drum upright.



(Left) Welded lime slacker in upright position. (Right) Drum tilted, showing handle and stop. Photos (Wilson Welder and Metals Co., Inc.).

Inside is a mixing element, driven by a ⅓-hp. motor running at 1750 r.p.m. and geared 5 to 1. The large gear drives a ¾-in. shaft, mounted on Timken bearings, turning a four-blade paddle which keeps the lime stirred during the slacking process.

A handle is welded to the outside for tipping the drum to empty it and a stop is welded to limit the degree to which the drum will tip. The gear case, shown above the motor, is flame cut and welded. The only bolts used in the entire construction are for mounting the motor.

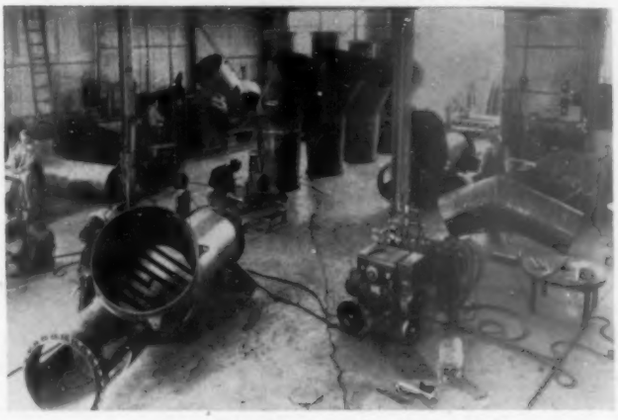
» «

Ship's Propeller Gets Hard-Facing Protection

★ This unusual close-up shows a cobalt-chromium-tungsten hard-facing alloy being applied to a ship's propeller blade. The ship, the "Lord Kelvin," draws an oceanic cable-laying plow designed and used by the Western Union Telegraph Co. Hard-facing the propeller is expected to overcome the effects of cavitation and erosion which are encountered in heavy-duty service. This hard-facing overlay was applied by means of the "dual" carbon arc.

In this type of carbon arc, the current passes from one carbon electrode to the other carbon electrode. The base metal is not part of the circuit.

Applying non-ferrous hard-surfacing alloy to a marine propeller. Photo (Haynes Stellite Co.).



Pomona Pump Co. fabricated 16 pumps for canal lifts. They were made from mild steel and Corten rolled plate by means of flame cutting and arc welding. Photo (Hobart Bros. Co.).

Welded Steel Irrigation Pumps Are Gaining In Popularity

★ A large welded pump order recently completed by the Pomona Pump Co. of Pomona, Calif., consisted of 16 huge Mixflor vertical pumps for the Contra Costa high line canal, a part of the Central Valley water project. These 16 pumps are used as canal lifts and were installed in four pumping stations of 4 pumps in each station, successively lifting over five million gallons of water per hour through four lifts varying from 25 ft. to 50 ft. in height, and with a total connected load of 3800 hp.

These pumps lift water out of the lower San Joaquin River, and boost it up into a canal distributing system in Contra Costa County for crop irrigation. They were completely built and fabricated at the Pomona factory, and weighed a total of 40 tons. Approximately 75% of this weight consisted of the discharge elbows and base mountings which were shaped and fabricated from rolled steel plate.

The Pomona Pump Co.'s welding shops, one bay of which is shown in the photograph, are well equipped to turn out these large units efficiently. Cutting and trimming is done entirely by the oxy-acetylene torch and the welding is almost entirely done by Hobart arc welders of 200 amp., 250 amp. and 300 amp. capacities.

The fabricating job entailed the welding of mild steel and Corten steel plates and shapes varying from ¼ in. to 1¼ in. in thickness, and all types of welds and in all positions. Welded steel fabrication of large pump units is becoming popular with reclamation engineers.

» «

Welding Saves Extensive Rebuilding Job

★ When oil wells were drilled in a certain townsite lease more than eight years ago, plans were drawn up for eventually installing a certain type of gear reduction unit for powering the individual well drives.

With better understanding of lifting problems in the field, it was decided to install a heavier gear box which, the manufacturer stated, would fit the foundation originally cast to conform with earlier specifications furnished at the time the pumping plan was drawn up.

The new case did fit the foundation, but the overhang of one crank was 4½ in.

This welded offset provided a rigid pump drive and a saving in equipment.

greater than figured, thus throwing out of line by that much the link between gear box and well pumping rig. Rather than install an offset drive, with additional bearings and loss of power therein, which seemed to be the only solution of the difficulty, since the wells were already drilled to fit original specifications, the welder suggested putting the offset in the rod which linked gear box crank and well pumping rig.

To provide the required alignment, the original connecting rod was cut, and a length of 4-in. pipe welded to the stub at the pump. This 4-in. pipe and the original rod were then welded together and a ⅜-in. plate welded tangent to both pipes, stiffening the weld and providing a rigid drive for the pump without changing either setting or requiring additional equipment.

» «

Body Repair Shop Makes Two Seats Out of One

★ An auto body repair shop certainly gets some funny ones!—crumpled fenders, battered bodies, fractured frames, broken axles, smashed grills and radiators—even total wrecks. On top of this variety of repair work, the shop is asked to satisfy the wishes of customers who may want to carry 3 to 5 tons on a 1½-ton chassis.

Take the case of Carnegie Body Co., Cleveland. With a lot of jobs on hand, involving every type of body and frame repair, a customer came in and asked them to make two individual front seats out of the conventional single one. Besides, requested the customer, one of the seats had to be fixed so it could be taken out and the space used for hauling samples, packages, etc. On top of it all, he didn't want to spend much.

Fig. 2—New arc welded seat frame.

Fortunately, the shop had the equipment necessary to do the job economically and still make a decent profit. They had tools for cutting the seat frame, bending the pieces into proper shape and putting them back together again.

Details of the job are shown in the pictures. Figure 1 shows the driver's seat intact and slots in the car floor to hold the other seat. Then the shop mechanic-welder fabricated the new frame from half of the original one. Figure 2 shows the new arc welded seat frame. Figure 3 illustrates the job ready for the upholsterer.

All told, the job took only a few hours, no new material, (save a little bit of steel salvaged from scrap) and the customer was entirely satisfied. So was the shop, because it made a nice profit and upheld its reputation for handling any job that comes along.

Fig. 1 — Driver's seat was left intact. Slots were cut in body floor to hold other seat.

Photos, shown Figs. 1-2-3, through courtesy of Lincoln Electric Co.

Fig. 3—Rebuilt seat ready for the upholsterer.

Machinery Now Licensed for Manufacture of Composite Metal

A machine which produces a new composite metal has been licensed for manufacture by the United Engineering and Foundry Co., Pittsburgh, Pa. The license has just been granted by R. E. Kinkead, engineer and consultant in welding, 3441 Lee Road, Cleveland, Ohio.

The new metal makes available—at cost savings of 15% to 20%—wearing qualities which are claimed to be better and more lasting than those of competitive materials. While possessing all the advantages of such materials, plus large cost savings, the new metal has none of the disadvantages, it is stated. The new material is ordinary steel with the surface alloyed by addition of chromium and nickel.

Because it provides better wearing qualities at substantial cost savings, the new metal is significant not only to the steel industry, but to manufacturers and users of products in the almost unlimited field where the benefits of the new metal will be clearly apparent. The metal can be utilized to increase the durability of countless products which, in the past, have had the limited wearing qualities of ordinary steel.

Advantages of the new metal, particularly its long service life and low cost, will influence its adoption for such products as: rain spouting, stoves, heating equipment, cooking utensils, plumbing fixtures, washing machines, sinks, bath tubs, piping, milk pails, dairy plant machinery and equipment, farming utensils, food making equipment, candy manufacturing machines, chemical plant equipment, paint making machinery, ships and boats of all types, automotive parts, airplane structures, railroad equipment, tanks and containers, water pipe, many types of machinery such as pumps, equipment for the manufacture of rubber, leather and textiles, as well as many other items whose maximum utility and service life is dependent upon resistance to rust and other destructive agents.

Capable of being made in thicknesses comparable with paper—.010 in.—the new metal can be produced within predetermined specifications. The process is also controllable for production of various alloys. Pickling, shot blasting, cold reduction, polishing or other operations may be carried out at costs which are customary with ordinary materials.

The new machine, which makes possible the production of this new composite metal, and which has just been licensed for manufacture, utilizes the Lincoln "Electronic Tornado" process of automatic carbon arc welding.

» «

NOW IS THE TIME
To Join the
AMERICAN
WELDING
SOCIETY

New Product Developments

Victor machine cutting torch holder.

Universal Cutting Torch Holder

★ The modern procedures of flame-cutting and flame-machining require a wide range of angular torch adjustments. To facilitate ease of adjusting the machine cutting torch to all horizontal and vertical positions, Victor Equipment Co., 844-50 Folsom St., San Francisco, Calif., have designed and are now producing a machine cutting torch holding member with a large ball and socket joint which will permit the torch to be clamped in an unlimited number of required angles.

The conventional ratchet type vertical adjustment is actuated by a large and convenient hand wheel. This new adjustable machine cutting torch holding device may be fitted to virtually all standard types of automatic torch guiding machines as well as to lathe tool holders for flame machining.

» «

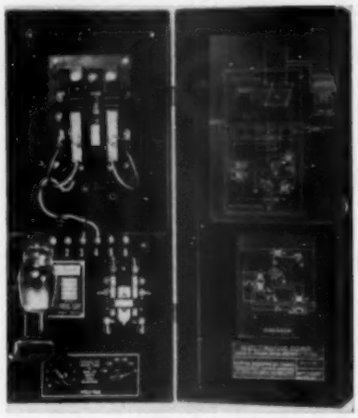
Welding Fitting for Pipe Applications

★ Pipe welding is simplified considerably by the use of a new type of forged steel welding fitting which has an annular lip forged integral with the fitting. This lip centers the fitting accurately in the pipe and eliminates the need for back-up rings, clamps and guides, to hold the fitting in proper position for welding. This new fitting is sold under the name of "Centring" Weldell, by the manufacturer, Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill.

"Centring Weldell" has an annular lip to center the fitting.

Weld Timer and Contactor

★ A combination weld timer and contactor to provide positive weld timing control for virtually any manually-operated 1 to 15 kva. spot welder, is announced by Weltronic Corp., 2832 East Grand Blvd., Detroit, Mich. Available for either 110, 220 or 440 voltages and 25, 50 or 60 cycle frequencies, the new timer-contactor unit, known as "Model 90-53" is adjustable in one-cycle steps over the standard 1 to 60 cycle timing range.



Weltronic timer-contactor provides accurate timing for manually-operated 1 to 15 kva. spot welders.

Featuring low cost maintenance, as a result of absence of moving time elements, and having removable contacts for quick replacement, the new timer-contactor provides a compact, easily installed means of controlling timing accuracy for any type of work within capacity of the spot welder with which it is used. The unit consists of a single electronic tube, a relay and a contactor together with time selector switch mounted in a compact, spring hinged cover base. A bulletin describing the timer-contactor "Model 90-53" is available. A copy can be secured by writing to the company.

» «

For Cast-Iron Welding

★ The Chicago Hardware Foundry Co., North Chicago, Ill., has developed two new rods for cast-iron welding. "Fluxed Rod" Fusewell No. 28 is a pre-fluxed cast-iron welding rod for gas welding. It contains in coating form all the necessary fluxes for sound, fluid cast-iron welds. The flux is sufficient for the dirtiest castings and of small enough bulk not to interfere on clean castings. Use of this rod eliminates need for loose canned flux in this type of welding. Supplied in all sizes in both round and square.

Machineable Cast-Iron Electrode—Fusewell No. 22—is a coated cast-iron welding electrode for a-c. or d-c. operation. Machineable cast-iron deposits on cast-iron can be made with this electrode with a 70% reduction in preheating. This electrode requires the use of only 300 deg. F. prewarming and is recommended for electric welding of cast-iron when similar properties of color, expansion and strength are required. Supplied in ⅛-in. diameter center gripped.

» «

500 Amp. A-C. Arc Welder

★ Hampton Electric Tool Co., 700 Walnut St., Edgewood (Pittsburgh), Pa., has recently added to its line of a-c. electric welders. This new Model E2F welder is designed to operate on either 220 or 440 volts, and will supply two operators simultaneously from 30 to 280 amp. each. By shifting a copper bar on top of the welder it can be operated by one man using from 30 to 560 amp. Machine has a continuous rating of 500 amp.

Electrodes from 1/16 to ½ in. diameter can be used with this machine, it is claimed, making it possible to weld the thinnest automobile fender up to the heaviest casting. Welding range is controlled by two rotary switches. There are 40 welding "heats" in the entire range.

The machine is 20 x 26 x 35 in. high and weighs 460 lbs. It has large handles and is mounted on four easy-to-roll, ball-bearing casters. Hampton welders are being distributed through jobbers.

Model E2F Hampton a-c. welder.

» «

Reinforced Welding Helmet

★ A new light-proof seamless welding helmet, designated No. 406, having reinforced side ribs has been announced by Chicago Eye Shield Co., 2300 Warren Blvd., Chicago, Ill. Made in one piece from vulcanized fibre, without rivets, this new welding helmet has been designed with two reinforcing ribs on each side. The ribs, moulded in the fibre, strengthen the helmet, add to its rigidity, and prevent warping.

Light weight seamless welding helmet.

Another feature listed for this helmet is a newly designed lens holder, so made that the entire lens holding unit may be removed by loosening two screws. The cover glass or welding lens can be quickly removed or replaced without the use of tools. The headgear can be adjusted to required size and once adjusted, it will remain in position until changed. Wearing comfort and even weight distribution is assured.

Complete information about this new welding helmet can be had by writing to the manufacturer direct.

» «

500-watt Ohmite resistor.

New 500 or 1000 Watt Ohmite Resistors

★ Shown here is one of the big resistors recently introduced by Ohmite Manufacturing Co., 4835 Flournoy St., Chicago, for heavy-duty service. It is 12 in. long, 2½ in. in diameter, and is rated at 500 watts. It is second in size to the 2½ x 20 in., 1,000 watt Ohmite resistor.

The resistance wire is accurately, uniformly wound on a porcelain core. Special Ohmite vitreous enamel permanently locks, insulates and protects each turn of wire on the porcelain core—prevents shorts, efficiently conducts away generated heat, insures continuous trouble-free service. The resistance wire is both mechanically locked and brazed to the terminal lugs to assure good contact.

Ohmite resistors are available in fixed, adjustable, and tapped, regular and non-inductive, general-purpose and precision types. They are stocked in all standard wattages and resistances.

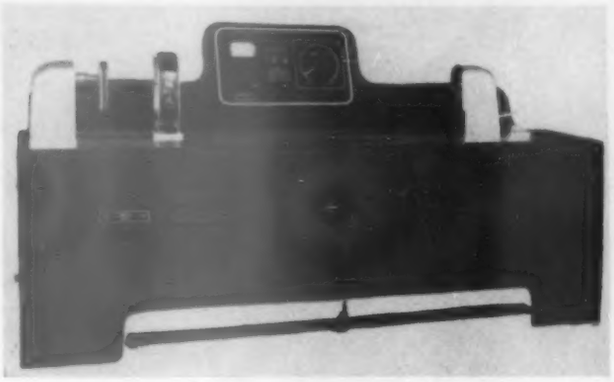
» «

Two New "Magnaflux" Units

★ Recently the Magnaflux Corp., 25 West 43rd St., New York City, has made available two new magnetizing units both transformer operated. The units provide means whereby parts may be magnetized and demagnetized. The DT type will handle parts up to 72 in. long and is used in industries, such as aircraft and automotive fields, and is so constructed that the wet method of inspection can be applied, while the magnetizing current is on and the part is in the machine. The detection liquid is flowed over the part by means of a nozzle connected to a tank and pump which are integral parts of the unit.

The TF-203 type is for small parts not exceeding 20 in. in length. It functions quite similar to the DT type, exceptions being that the coil serves as a demagnetizer and the tank and pump features are not included. This unit has been adapted for tools, pipe, machinery items and other small parts.

Type DT magnetizing unit will handle parts up to 72 in. long. Used in aircraft and automotive industries.



» «

Model 60 C-F Welding Positioner Has 6,000 Lbs. Capacity

★ Cullen-Friestedt Co., 1300 S. Kilbourn Ave. has developed the Model 60 Welding Positioner which has a capacity of 6,000 lbs. Both the table tilt and table rotation movements are power operated, each having its own independent motor and control.

Table can be rotated through a full circle regardless of angle at which it is tilted. Table can be tilted through an arc of 135 deg. from horizontal position. Gears for rotating the table and tilting the table are self-locking in all positions.

Height of table is adjustable from 42 in. to 54 in. on machines with standard bases. Positioner can be furnished with a special mounting for handling extremely large work. Table can be removed so special fixtures or jigs can be mounted directly on positioner. All surfaces of work can be maneuvered for positioned welds, except the portion in contact with the table.

All mechanism of the positioner is below the table and does not interfere with the work, regardless of the position of table. Capacity is based on center of gravity of load being 12 in. from face of table and also on center of gravity of load being 6 in. to the side of axis of rotation.

Both table "tilt" and table "rotation" movements are power operated.

» «

New Inexpensive Sweatband

★ For industrial workers, or in fact, anyone whose work causes the perspiration to flow —American Optical Co., Southbridge, Mass., has a new, inexpensive sweatband to be worn across the forehead. Made of synthetic sponge, the handy little device really absorbs sweat and in addition can be used over and over again after washing. Dimensions are 6¾ in. by 1¾ in. Equipped with elastic headband and buckle, the sweatband can be adjusted to fit any size head.

» «

Engine-Driven Arc Welder Has Exceptional Capacity

★ A new 200-amp. engine-driven arc welder, which is exceptional in light weight, small size, and low cost for an engine-driven unit of its capacity, is announced by The Lincoln Electric Co., Cleveland, Ohio. The new welder, designated the "SAE-200 J" is of the Junior type, and affords a new experience in moving and handling engine-driven welding equipment. It is light enough to be wheeled readily by one man, or lifted easily on its single balancing hook by means of the average moderate-capacity chain or crane lift. The weight is under 900 lbs.

Ease of moving and handling the unit is further enhanced by its size which has an advantage in the matter of floor space. Dimensions, stationary model, are: length, over radiator grille 56 in.; over hand crank 63⅞ in.; width 20¼ in.; height 37¼ in. The portable model (shop type) is same length as stationary type and 27½ in. wide (wheel clearance) by 44½ in. high. Floor space required for the stationary model is only 8 sq. ft.

The welder's low price places the many advantages of welding within reach of garages, automotive repair shops, job welders, sheet metal contractors, light-metal fabricators and all other concerns who can utilize portable welding to advantage in the many profitable applications for engine-driven welders.

The "SAE-200 J" meets requirements for a wide range of applications for d-c. arc welding. It welds light-gauge metal by the metallic arc process; also car fenders, bodies, and galvanized sheet by the carbon

New Lincoln 200-amp. engine-driven arc welder.

arc method; repairs cast-iron parts such as cylinder heads and blocks; fabricates a wide variety of equipment; does hard-facing; and is effective in countless other applications. It produces a uniform current for speedy welding of practically all metals and alloys.

GENERATOR — Single-operator, variable-voltage type with laminated pole pieces, increasing arc stability and simplifying welding. Current range, welding duty, is 40 to 250 amp. for either bare, washed, or heavily-coated electrodes. Equipped with patented "dual continuous control," enabling independent adjustment of both open-circuit voltage and welding current.

NON-INFLAMMABLE INSULATION — Class B insulation, used in the armature of this welder, contains no inflammable materials. The coils, wound with glass-covered wire, are held in mica-lined slots, separated by mica dividers, and the leads are connected into the commutator by special, high-melting point solder.

CONTROL — Continuous voltage control (job selector), and current control make it easy to select any type of arc and any arc intensity to suit the job. Controls are self-indicating.

COUPLING—Generator frame is mounted directly to engine bellhousing and generator shaft is connected directly to engine flywheel by special type of flexible coupling.

MOUNTING—Base is made of heavy steel channel, strongly braced and welded. Engine generator and radiator are securely fastened to substantial channel frame. Sturdy metal grille protects radiator front.

CANOPY—Pressed steel canopy (enclosing cover), is supported by heavy steel members. A side door on either side is hinged at top and provided with ventilating louvres, with spring fasteners at bottom. Hinged door at rear provides easy access to welder control panel.

GASOLINE ENGINE — Four-cylinder type, 3-in. bore and 4-in. stroke with piston displacement of 113 cu. in. Capable of delivering 26 hp. at 1800 rpm. Fuel tank capacity is 8 gals.

» «

U.S.L. 500-Amp. A-C. Welder

★ The Owen-Dyneto Division of USL Battery Corp., Syracuse, N. Y., has just announced a new 500 amp. a-c. welder (Model 3W), which completes its line ranging in capacity from 150 to 500 amp. Designed to operate in current steps from 30 to 280 amp., by simply shifting a copper bar on top of welder the machine can be operated from 30 to 560 amp., having a continuous 500 amp. rating.

Electrodes from 1/10 to ½ in. in diameter can be used with this machine, which makes it possible to weld the thinnest automobile body and also the heaviest truck frame. Machine weighs 460 lbs.

Model 3W, 500-amp. a-c. welder.

» «

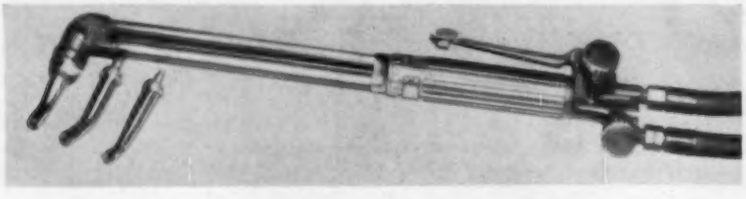
New Oxweld Nozzles For Oxy-Acetylene Gouging

★ A series of new oxy-acetylene gouging nozzles, for use with a standard hand-cutting blowpipe, such as the Oxweld C-32, has been announced by The Linde Air Products Co. These new Oxweld nozzles, which are available in three sizes, provide a means for quickly and accurately removing a narrow strip of surface metal from steel plate, forgings, and castings.

The nozzles are so designed as to deliver a relatively large jet of oxygen at low velocity. By proper manipulation of the blowpipe in which the nozzle has been inserted, a smooth, accurately-defined groove can be cut or gouged out of the surface of the metal. By using various standard size nozzles and manipulations, the groove can be varied in width and depth at the will of the operator.

Important uses for these new nozzles are: gouging the underside of arc welds; removal of weld metal, such as temporary tack-welds and defective welds; preparation of plate edges for welding; and maintenance and scrapping operations. A wide field of miscellaneous uses include gouging in metal-shaping and trimming processes. Further information about the new Oxweld gouging nozzles can be obtained from the nearest office of The Linde Air Products Co.

Gouging operations can be performed with these three special Oxweld nozzles, designed for use with a standard medium-pressure cutting blowpipe.

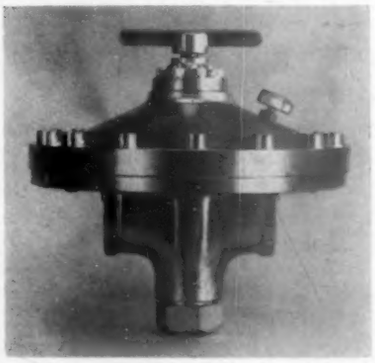


» «

Regulator for Scarfing or De-Seaming Operations

★ To supply the relatively large volumes of oxygen required for de-seaming and scarfing torches, Victor Equipment Co., 844 Folsom St., San Francisco, Calif., are now marketing a specially designed regulator Model L-150. Owing to its large gas capacity, this regulator can also serve large compressed air installations where uniform pressure control is desired.

The Model L-150 regulator has an outside diameter of 12 in. and a 10-in. diaphragm diameter, and is provided with inlet and outlet large enough to accommodate up to 1½-in. i.p.s. pipe.



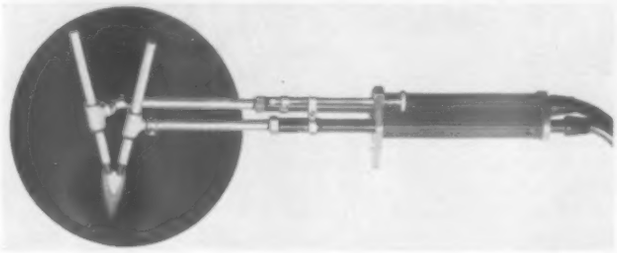
Victor Model L-150 regulator.

The regulator is designed for inlet pressures up to 250 lbs. and for delivery pressures up to approximately 225 lbs. maximum. Regulator inlet pressure is utilized to load the diaphragm and two conveniently located valves permit instant increase or decrease of working pressure. The manufacturer claims exceptional pressure accuracy, minimum tendency to freeze, large gas capacity, and extreme dependability.

» «

Marquette Has an A-C. "Arc Torch"

★ A-C. and d-c. arc welding users have been handicapped to some extent by lack of a suitable attachment for doing the many heating and welding jobs that demand an independent source of heat similar to that supplied by the gas torch. With the Marquette Arc Torch and a-c. welding current that



Marquette "Arc Torch" utilizes two carbon electrodes and an a-c. welding transformer.

difficulty has been largely overcome. With the new equipment it is now possible to do general heating jobs; preheating; welding of aluminum, bronze, copper, pot metal, German silver and other non-ferrous metals; braze; solder; and apply hard surfacing paste.

The Marquette Arc Torch operates on less current than when welding with the metallic arc and can be used with any a-c. machine. The Marquette Arc Torch is ideal for welding aluminum. Its soft, hot, easily controlled "flame" is especially suited to this application. It has been found by experienced aluminum foundries and factories to be one of the most economical and successful methods yet devised.

When frames, bumper brackets and other parts are to be heated for straightening the Marquette Arc Torch is adaptable as it is quick and economical. Preheating of light castings can be accomplished quickly and efficiently without defacing machined surfaces, it is claimed. Body metals and soft solders can be run to suit the needs and desires of the most severe critic. The accurate control of heat makes possible a soft flame ideal for this type of work.

Hard solders such as Easy-Flo, Sil-Fos, and other silver solders can be handled with ease and success. This brazing application to the repair of copper, brass, monel metal and all ferrous metals will find a ready application in such industries as: automotive, aviation, refrigeration, sheet metal and plumbing and heating shops.

The new Marquette Arc Torch is packed complete with two 10-ft. cables—2 sets each of ⅜-in. and ¼-in. Marquette Arc Torch carbons—2 ¼-in. carbon adaptors and a set of 2 copper terminal lugs besides the two regular Marquette taper jacks and a complete set of instructions for its operation. Further information can be obtained direct from Marquette Mfg. Co., Minneapolis, Minn.

» «

50-KW. Ace Spot Welders

★ Pier Equipment Mfg. Co., Benton Harbor, Mich., have added two new models to their line of Ace spot welders used for spot or projection welding, and, with suitable fixtures, for butt welding. They are both 50 kw. size, one motor-driven automatically-operated (see illustration), and one manually-operated by means of a new swivel-jointed foot treadle. Both have added refinements, such as new recessed automatic trip control and timing adjustment. An 8-point heat regulating switch for adjusting secondary voltages and current, is furnished on these models, and an entirely new and lower horn may be adjusted to provide spacing up to 15 in. on standard welders. The transformers are designed for operation on 220-volt, 60-cycle supply.

Ace motor-driven spot welder (50 kw.).

» «

Polyphase Motor-Driven Portable Grinders

★ Sawyer Electrical Mfg. Co., Los Angeles, Calif., has recently offered a new type of grinder, available in 1, 1½ and 2 hp. portable sizes and 3½ hp. suspended aerial type. The new grinder uses Sawyer's two-pole, polyphase motor design.

Sturdy electrical construction eliminates commutator brushes and centrifugal switches, which combined with moderate rotor speeds, assures low maintenance cost. Motor efficiency is high and power "pullout" is over twice rated capacity. Motor on each type and size of grinder is totally enclosed, eliminating any possibility of grinding dust entering the stator. Bearings are of standard double-shielded, factory lubricated type of adequate size to assure low maintenance. Rotor is made as an integral part of the shaft, and this unit, mounted on anti-friction ball bearings, is the only rotating part.

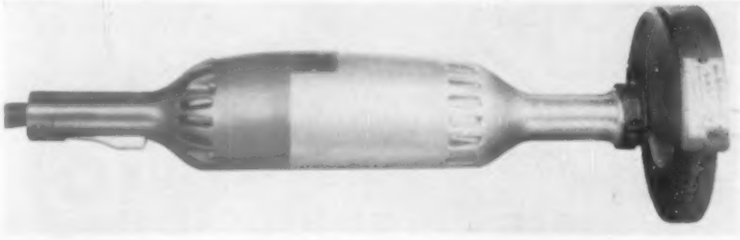
Grinder specifications on all sizes involve a 220-volt, 3-phase, 60-cycle motor and the speed of all sizes, with exception of hi-speed gear drive machine, is 3600 r.p.m. The hi-speed unit is geared to drive at 5400 r.p.m. Weights run from 16 lbs. on the 1 hp. to 65 lbs. on the suspended 3½ hp. unit.

SPECIAL COURSE IN PRINCIPLES OF WELDING

Rensselaer Polytechnic Institute, Troy, N. Y., in conjunction with its welding laboratory will again offer a special course dealing with principles of welding for the benefit of engineers. This will be an intensive course offered to a limited group of engineers from industrial plants who are interested in obtaining special training in this field. It will cover the basic principles of welding with associated laboratory experience, all within a period of four weeks. An optional two weeks of experimental work is offered. Time will be devoted to metallurgy theory, theory of welding and structural design. Laboratory experience will include heat treatment, microscopic examination, welding, cutting and physical, magnetographic and radiographic testing. There will be regular library assignments, discussion groups and visits to nearby plants. The optional two weeks will be available for more laboratory experience in particular branches such as the weldability of a certain type of steel, spot welding, or any other phase which may have a special appeal.

This course will begin February 5, 1940. Tuition fee will be $100.00 for the basic four weeks' course and an additional $50.00 for the optional two weeks. This course will be open to graduates who have completed courses leading to degrees in engineering or allied sciences. It will also be available to men whose responsibilities in industry have given them an experience equivalent to an engineering course. Each applicant must submit a record of his experience including references from men who are familiar with his work.

Further information can be obtained from Prof. WENDELL F. HESS, Dept. of Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. Applications must be received not later than January 2, 1940.



Sawyer polyphase motor-driven grinder.

News of the Industry

WELDED CABLE SADDLES—In the article on "Welded Cable Saddles" prepared by JONATHAN JONES, chief engineer, Fabricated Steel Construction Division of Bethlehem Steel Co., the following statement was made, "It is believed that the cable saddles of the Tacoma Narrows Bridge represent the first departure in the United States from the use of steel castings, and the first use of welded structural plate, for these heavy and rather complicated pieces." Since publication of the article, the author has called our attention to the fact that although this statement is correct, it seems advisable to point out that welded cable saddles were used on two important suspension bridges in Canada, before their adoption for the Tacoma Narrows Bridge, described by the author.

» «

THE JAMES F. LINCOLN ARC WELDING FOUNDATION, Cleveland, Ohio, offers the following thoughts by way of defining the word "progress":

Progress is a tremendous force in human existence. It sweeps inexorably forward, acclaiming today, as scientific fact that which—10 years ago—was only scientific theory. Frequently, it refutes, in the actual culmination of some scientific advance, the very forward step which—a decade ago—science declared impossible.

In all of its varied manifestations, progress produces benefits which are incalculable . . . Because of progress in building construction, we have better homes . . . Because of progress in manufacture of household appliances, we have more comforts, greater conveniences . . . Because of progress in automotive manufacture, we have better automobiles . . . Because of progress in transportation, we have faster, more comfortable trains . . . Because of progress in aviation, we have safer airplanes . . . Because of all the benefits of progress, every one enjoys a higher standard of living.

Progress drives us onward . . . It forbids our standing still!

» «

TEXAS TECHNOLOGICAL COLLEGE, Lubbock, Texas, will hold its fourth bi-annual welding conference on February 2-3, 1940. More than 300 welding-minded men attended the 1938 Lubbock Conference.

» «

LOUISIANA ENGINEERING SOCIETY will hold its fifth annual meeting in New Orleans, La., on January 12-13, 1940. Meetings will be held at the St. Charles Hotel.

» «

JOHN HUNTINGTON INSTITUTE TO CONTINUE WELDING COURSES

Recognizing the need for training in the fast growing welding field, the John Huntington Polytechnic Institute, Cleveland, Ohio, announces continuation of the 5-day courses in arc welding design and practice which it has sponsored in collaboration with The Lincoln Electric Co., Cleveland, Ohio.

Revised in line with suggestions from a large number of men who have attended its past sessions, the course offers engineers and designers the opportunity of studying intensively the redesign of products and structures for arc welded construction. The course includes talks and demonstrations on welded design, as well as discussions of problems on welding procedures and technique. Some of the included topics are: arc welding generators; performance of the welding arc shown by magnified screen projection; a-c. and d-c. current in welding typical joints; the value and use of the shielded arc in design; calculation of stress distribution in welded joints; use of rubber

» «

Features which assure SUPERIOR WELDING QUALITIES of

Use of Purest Raw Materials Obtainable, such as Electrolytic Copper 99.96 in purity and Electrolytic Zinc 99.99 plus.

Strict Laboratory Control; Uniformity of Mixtures and Casting Temperature.

Double-Deoxidation Process which eliminates injurious gases.

PENN BRONZE—a general-purpose rod, melting at 1620° F. Tins readily and uniformly on galvanized, malleable or wrought iron, as well as steel, brass, bronze and any other non-leaded metal with melting point above 1850° F.

TITAN MANGANESE BRONZE—especially adapted to production of tough, hard deposit. Particularly recommended for cast-iron repairs, where extremely dense, non-porous weld is essential.

Submit your particular bronze-welding problem for solution by our engineers. Recommendations gladly forwarded, together with generous sample for trial in your own plant.

Titan Metal Manufacturing Co.
Bellefonte, Pennsylvania

JOIN THE
AMERICAN WELDING SOCIETY
DO IT NOW!

models and polarized light in studying stress distribution, etc.

Previous sessions of this course have been attended by engineers, designers, architects, production engineers, welding supervisors, foremen and operators, as well as other individuals from industrial concerns throughout the country.

Courses will be offered at Cleveland during the weeks of October 30, December 4, January 8, February 12, March 25, April 22, and May 27. As in the past, each session will be under the direction of E. W. P. SMITH, welding consulting engineer.

Personals

R. L. FORNEY, assistant to the managing director of the National Safety Council, has been appointed director of the Council's Industrial Division, effective January 1, 1940. Mr. Forney will replace W. DEAN KEEFER, who ended 21 years with the Council to join the Lumbermens Mutual Casualty Co. as assistant to the vice-president in charge of safety engineering, with offices in Chicago. Mr. Forney, in addition to his duties as assistant to the managing director, a responsibility he will retain, has directed the Council's Statistical Division for 12 years.

» «

GENERAL ELECTRIC EXECUTIVE CHANGES CHARLES E. WILSON, executive vice president, was elected president and PHILIP D. REED, assistant to the president, was elected chairman of the board of directors of the General Electric Co. They will take over their new responsibilities January 1st, succeeding GERARD SWOPE and OWEN D. YOUNG, who will become honorary president and and honorary chairman of the board, respectively.

CHARLES E. WILSON, who began his career in business as an office boy at the age of 13, has been executive vice president of General Electric since December, 1937. It was a new position when he was appointed to it, after having been vice president in charge of the appliance and merchandise department since 1930.

Mr. Wilson was born in New York City on November 18, 1886. He began working as an office boy in 1899 with Sprague Electric and went from office boy to shipping clerk, factory accountant, production manager, and then assistant superintendent in 1914. Shortly after that he was appointed sales manager.

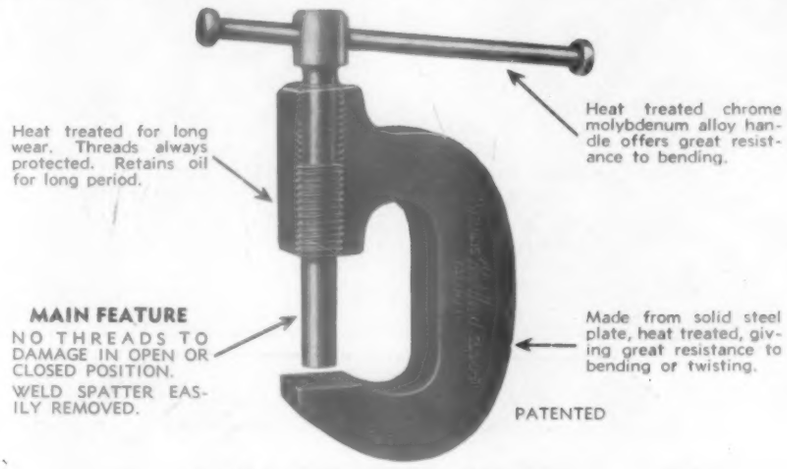
BUILDING INSPECTORS ATTEND WELDING CLASS—Fifty members of the Pittsburgh Bureau of Building Inspection and the Bureau of Tests of Allegheny County attended the opening session of an inspectors' course recently held at the East Pittsburgh works of Westinghouse Electric & Mfg. Co. The city's new welding code permits welded construction for the first time, and inspectors of the two bureaus are spending one day each week for 8 weeks in the course to obtain a thorough grounding in the fundamentals of welding technique and inspection.

JOHN J. MURRAY, divisional engineer of the Pittsburgh Bureau of Building Inspection, and W. W. REDDIE, of the Westinghouse welding section, are directing the course jointly. According to Mr. Reddie, the Pittsburgh code is one of the most advanced in the country. Other cities have drafted welding provisions into their building codes, but in no other instance has the ordinance dealt specifically with welding; nor have the provisions been so nearly in keeping with modern welding practice as in the Pittsburgh code.

Class attending opening session of welding inspectors' training course at Westinghouse. Engineers from City of Pittsburgh and Allegheny County attended.

"Red Head"
WELDING CLAMPS

Withstands All Welding and Handling Abuses


Heat treated for long wear. Threads always protected. Retains oil for long period.
Heat treated chrome molybdenum alloy handle offers great resistance to bending.
MAIN FEATURE
NO THREADS TO DAMAGE IN OPEN OR CLOSED POSITION.
WELD SPATTER EASILY REMOVED.
Made from solid steel plate, heat treated, giving great resistance to bending or twisting.
PATENTED

14 STOCK SIZES

Special Sizes and Shapes Furnished for Special Applications

INDESTRUCTIBLE CONCEALED THREADS

Red Head Welding Clamps have been especially designed for welding service. Their construction eliminates the trouble caused by weld spatter or accidental damage to threads. A clamp that will stand up under the most rigorous service over long periods of time.

A trial will convince you. Send for sizes and prices today.

TERRITORIES OPEN FOR JOBBERS

CHICAGO BOILER COMPANY

1965 Clybourn Avenue **Chicago, Illinois**

CHARLES E. WILSON

In 1923 he went to Bridgeport as managing engineer in charge of the conduit and wire business, and two years later he was appointed assistant manager of General Electric's Bridgeport works. In 1930 he was appointed manager of the merchandise department in charge of engineering, manufacturing and sales. In December of the same year he was elected a vice president of General Electric. In 1935 he was assigned the additional responsibility of directing all appliance activities, including refrgerators, electric ranges, and other kitchen appliances, as well as air conditioning equipment.

PHILIP D. REED, assistant to president of General Electric since December, 1937, was born in Milwaukee, Wis., on November 16, 1899. He joined the General Electric Co. in its law department in 1926, one day before his twenty-seventh birthday. He holds degrees both in electrical engineering and law. He received his engineering degree from the University of Wisconsin in 1921 and his doctor of laws from Fordham University in 1924. He is a member of Tau Beta Pi, honorary engineering society.

Mr. Reed's first job began while he was still a law school student, taking evening classes at Fordham, and in 1922, before his graduation, he became vice president and patent counsel for the Van Heusen Products Co. of New York. Before that he was patent solicitor for Pennie, Davis, Marvin & Edmonds of New York, and patent attorney for J. M. Van Heusen of Boston.

PHILIP D. REED

He entered General Electric in 1926 as assistant to Vice President C. W. Appleton of the law department in New York. In 1928 he was transferred to the incandescent lamp department, and from July 1, 1934, until his appointment as assistant to the president in December, 1937, he was general counsel for the lamp department.

MANGANAL

REGISTERED U.S. PATENT OFFICE

***NEW!* TITE-KOTE WELDING ELECTRODE**

for A. C. Welding

This newly-introduced electrode for A.C. welding is identical with the regular bare MANGANAL electrode, except that it possesses a ***SPECIAL SELF-PEELING COATING that in no way retards the quick cooling of the weld deposit.***

Welds made with this new electrode possess the same ductility and toughness possessed by deposits made with MANGANAL bare electrodes.

Available in 1/4, 3/16, 5/32 and 1/8 in. sizes (14 in. length). Packed in 50-lb. containers.

Write for name of nearest Manganal distributor

STULZ-SICKLES CO. Sole Producers **91 N. J. Railroad Avenue, NEWARK, N. J.**

Manufacturers of MANGANAL Manganese Nickel Steel WEDGE and APPLICATOR BARS, Hot Rolled PLATES, etc.

Obituary

FRANK LUDLAM, assistant secretary and assistant treasurer of THE INTERNATIONAL NICKEL CO., INC., died on December 8th at his home at 1130 Park Ave., New York City, after a long illness.

Trade News

G.E. UPS DIVIDEND—A dividend of 65 cents a share for the fourth quarter of 1939 has been declared by the directors of General Electric Co., based upon an estimate of the company's net income for the year. This is the 169th dividend on common stock. The payment of 65 cents a share for the fourth quarter makes a total of $1.40 a share in dividends to stockholders for the year 1939, compared with 90 cents a share for 1938.

» «

COURSE IN ARC WELDING DESIGN AND PRACTICE

A course in "Arc Welding Design and Practice" was held in Erie, Pa., during the week of December 11 to 15, 1939, for the engineers, designers, superintendents and foremen of industrial plants in Northwestern Pennsylvania.

The course, which was sponsored by the Lincoln Electric Co. of Cleveland, Ohio, was held at the Erie County Milk Ass'n Auditorium located at 2023 Peach St. in Erie. Lectures on such subjects as: "The Shielded Arc in Design," "Welded Design," "Stress Distribution Studies by Polarized Light," "Operator Qualification" and "Cost Control" were given by E. W. P. SMITH, welding engineer.

» «

WESTINGHOUSE BUSINESS EXCELLENT—Orders booked for the first ten months of 1939 amounted to $176,896,557, as compared with $125,323,348 for the same period of 1938. The company's backlog of unfilled orders is approximately $66,000,000, as compared with a backlog of $40,188,150 on December 31, 1938.

» «

PROGRESSIVE WELDER WILL HAVE NEW PLANT—Contracts for the design and construction of a modern streamlined plant for the Progressive Welder Co., manufacturer of hydraulic welding and punching equipment for special and general industrial uses, have been awarded to The Austin Co. The new plant will occupy a three-acre site at 3080 Outer Drive, at Moenhart Ave., Detroit, Mich. It will be ready for occupancy February 15th. The initial unit will provide more than 27,000 sq. ft. of floor space.

» «

STEEL PRICES TO BE MAINTAINED—In spite of rising costs and many uncertainties, the Carnegie-Illinois Steel Corp., desiring to cooperate in preventing inflationary tendencies, has announced reaffirmation of its present prices on rerolling blooms, billets and slabs, sheet bars, forging blooms, billets and

Fig. 1—Close-up of a fillet weld as used on 10-ton crusher base. Photo (Air Reduction Sales Co.).

Fig. 2—A group of flame-cut steel parts which displaced steel casting. Photo (Airco).

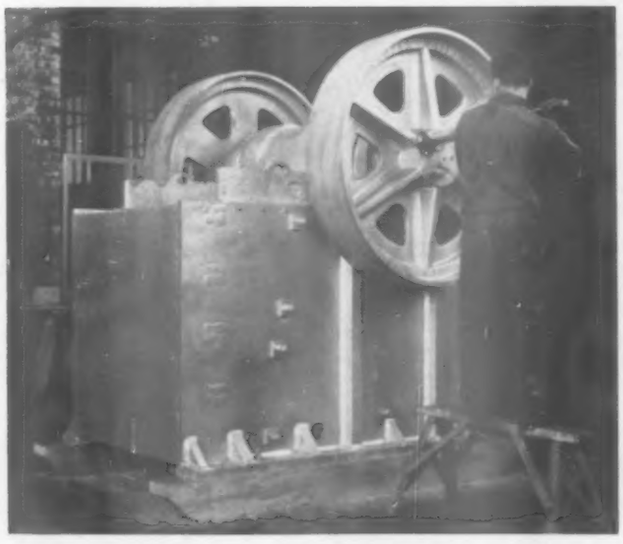
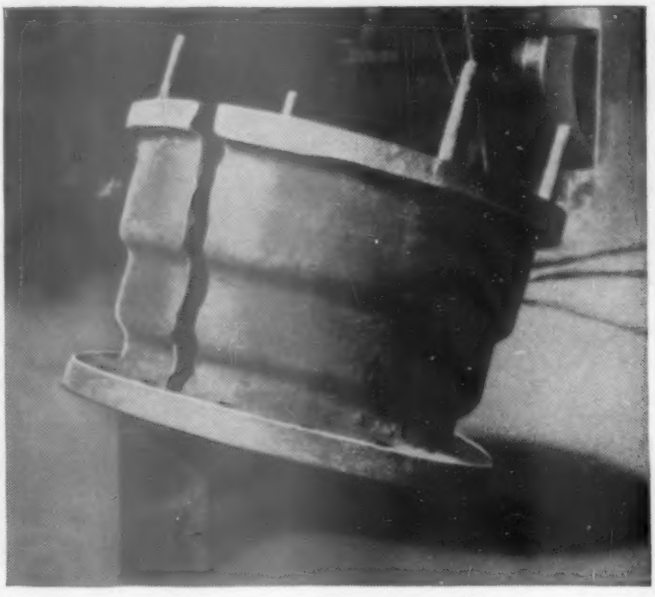


Fig. 3—This 10-ton rock crusher was completely fabricated by means of flame cutting and arc welding. About 1000 lbs. of electrodes were used on this heavy structure. Photo (Air Reduction Sales Co.).

What would you do in an emergency like this?



A GREAT LAKES FREIGHTER was carrying a valuable cargo of perishable goods when its engine suddenly became disabled off Fort William, Ontario.

Hurried examination revealed the badly cracked iron casting shown above. Because of the cargo, minutes meant dollars, and repair-welding was obviously the only way out.

Before looking to see how this problem was solved, why not figure out what you yourself would have done.

Check your answer with the solution on page 57

slabs, carbon and alloy bars, structural shapes, steel sheet piling, rails, plates, electrical sheets, vitrenamel and galvanized sheets, long terne sheets, black plate and cold rolled sheets for shipment to and including March 31, 1940, for delivery and consumption within the United States.

In order to bring about a better relationship between hot rolled sheets and cold rolled sheets some extras applicable to hot rolled sheets, including certain pickling extras, have been revised downward, while the base prices of hot rolled sheets and hot rolled strip have been revised to $2.125 per 100 lbs., base delivered Pittsburgh, and $2.13 per 100 lbs., base delivered Chicago.

» «

TWO NEW MUREX DISTRIBUTORS

THE ARTHUR C. HARVEY CO. and the R. C. NEAL CO., INC. have recently been appointed distributors of Murex electrodes by the Metal & Thermit Corp., New York City. The New England states, except Vermont, are covered by the Harvey Co., whose address is 60 Everett St., Allston District, Boston, Mass., while the western and central portions of New York State will be served by R. C. Neal, whose headquarters are at 76 Pearl St., Buffalo, N. Y.

» «

THE MOSSMAN-YARNELLE CO., Ft. Wayne, Ind., have been appointed by the Harnischfeger Corp. as welder and electrode agents. They will operate on an open basis. Mossman-Yarnelle are located at 230 Pearl St., Ft. Wayne, Ind.

» «

RICHARD E. ELA CO.—Announcement has just been made by the HARNISCHFEGER CORP. of Milwaukee, Wis., appointing Richard E. Ela Co., as agents for P&H-Hansen welders and P&H Smootharc welding electrodes. The firm is located at 921 E. Washington Ave., Madison, Wis. They will operate on an open basis, under the supervision of Mr. Steidl of the Milwaukee office.

» «

THE HARNISCHFEGER CORP. of Milwaukee, Wis., manufacturers of P&H-Hansen arc welders and Smootharc welding electrodes, announce the appointment of WILLIAM FREDERICK, 2200 Taft St., Wichita Falls, Texas, as an agent for sale of P&H-Hansen welders and Smootharc welding electrodes, on an open basis. Mr. Frederick will operate under supervision of the Harnischfeger Dallas office.

» «

ACME WIRE & IRON WORKS, 3043 W. Laurel St., San Antonio, Texas, has been appointed welder and electrode agent for Harnischfeger Corp., Milwaukee, Wis., on an open basis. They will operate under supervision of the Dallas office.

» «

MCKAY "CERTIFIED" STAINLESS ELECTRODES —Joseph T. Ryerson & Son, Inc., of Chicago, have recently become distributors of McKay "Certified" stainless steel electrodes. These specialized electrodes, covering the whole range of analyses encountered in stainless-steel welding, are stocked by all the Ryerson branches, including Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, and Jersey City, as well as the central plant in Chicago. A certificate of weld-deposit analysis accompanies every package sold.

» «

THE BALBACH CO. WILL HOLD A THREE-DAY WELDING CONFERENCE—On January 16-18, 1940, The Balbach Co., 1201 California St., Omaha, Nebr., will hold its Annual Welding Conference. It is the purpose of this annual event to provide as much practical instruction as possible in oxy-acetylene, arc welding, flame cutting and hard surfacing within the limits of the three-day program. A number of factory representatives will be in attendance at the Conference to demonstrate the merits of their equipment.

A.W.S. Activities

CLEVELAND SECTION A.W.S.—ERIC SEABLOOM, research engineer, Crane Co., spoke to the Section on the subject of "Destructive and Non-Destructive Testing of Welds on High Pressure Piping," at the monthly meeting held November 8 at Fenn College, East 24th St. and Euclid Ave. Mr. Seabloom also discussed production methods employed for hard-facing valve seats for high temperature service.

» «

MILWAUKEE SECTION A.W.S.—JAMES THOMPSON, chief engineer of Continnental Roll & Steel Foundry Co., East Chicago, Ind., spoke on "Engineering Uses of Steel Castings in Welded Structures" at the regular monthly meeting, November 24th. Meetings of this Section are held at the City Club, 756 No. Milwaukee St.

» «

DETROIT SECTION A.W.S.—"Licensing of Structural Welders" was the subject of discussion at the December 1st meeting held at the Detroit-Leland Hotel. GEORGE F. EMERY and HARRY BROAD, both of the Department of Buildings and Safety Engineering of the City of Detroit explained the provision of the new licensing requirements as set up in the building code. Effective December 1, 1939, all structural welders employed on field work must obtain a license from the city. The meeting enabled those who would be affected by this new requirement to become familiar with the licensing provisions and their method of enforcement.

» «

PHILADELPHIA SECTION A.W.S.—DR. H. J. MAXWELL, head of the metallurgical section of E. I. duPont de Nemours Co., presented a paper on "Welding Fabrication of Stainless Steel" at the Section meeting November 20th, which was held at the Engineers Club, 1317 Spruce St.

» «

CLEVELAND SECTION, A.W.S.—At the December 13th meeting held at the Cleveland Club, A. M. Unger, Welding Engineer of Pullman Standard Car Mfg. Co., presented an illustrated paper dealing with the welding of railroad equipment an a two reel motion picture on Pullman car fabrication was included.

» «

ST. LOUIS SECTION A.W.S.—At its meeting December 8th, the subject of electrodes and weldability of steel was presented by H. MCLEAN JASPER, consulting engineer of A. O. Smith Corp., Milwaukee, Wis. At the meeting sscheduled for January 12, 1940, HARRY C. BOARDMAN, research engineer, Chicago Bridge and Iron Co., will speak on "A.W.S. Standard Qualification Procedure."

Construction

THE M-A-R PIPE LINE CO., of Corpus Christi, Tex., will lay a new welded pipeline from the Saxet oil field in Neuces County, to Jim Wells County, a distance of about 35 miles. Ten-inch pipe will be used, and in addition, about 10 miles of 4-in. gathering lines will be laid in the Ben Bolt field.

» «

TEXAS-NEW MEXICO—Award of a contract for the construction of its 19-mile 14-in. welded crude oil pipeline, serving fields in Lea County, New Mexico, has been announced by the Texas-New Mexico Pipe Line Co.

» «

MEXICO—The construction of a welded oil pipeline from the producing region of Poza Rica, in the State of Vera Cruz, Mexico, to Mexico City, is expected to start in the near future. Pipe and other materials will be purchased in the United States.

THOUSANDS OF WELDING SHOPS
ARE MAKING ADDITIONAL PROFITS IN THIS NEW FIELD
Is your shop? Prepare your shop during the winter months for more profits next year.
U. S. Patents 2,013,818 and 2,051,234
Canadian Patents 365,296 and 369,723
ELECTRIC WELDED
Write for new catalog now
WIESE PLOW WELDING COMPANY, PERRY, IOWA
Originally New Process Plow Welding Co.

WELDERS Your Engine Driven Welder will provide correct heat at the arc if the motor is equipped with a sensitive PIERCE GOVERNOR.
ASK YOUR WHOLESALER
THE PIERCE GOVERNOR CO., Anderson, Indiana, U. S. A.

MAGNOLIA — Construction of a 138-mile welded gasoline pipeline from San Antonio, Texas to the port of Corpus Christi, is planned by the Magnolia Petroleum Co. This welded carrier will be of 4½-in. pipe.

» «

SHELL OIL, ETC.—A 50,000-gallon daily capacity gasoline plant in the Magnolia oil field of Arkansas, will be built in the near future by Gasoline Plant Construction Co., of Houston, Texas. The plant is being built for Shell Oil Co., Atlantic Refining Co., and other petroleum interests.

» «

THE SOUTHERN PIPE LINE CORP., of Corpus Christi, Texas, is laying a 24-mile welded 6⅝-in. crude oil pipeline to run from the Bentonville-Richard King oil field in west Neuces County (Tex.), to the Hunter station in the Saxet field. Brown & Root are the contractors.

» «

WELDED SS "EXPORTER" LAUNCHED IN RECORD TIME

The "Exporter" first of four fast freighters being built at a nationally-known shipyard, was launched recently, exactly 8 months and 8 days after her keel was laid. This feat was exceedingly unusual for a ship of her size—473 ft. long, and a gross tonnage of 14,450. With her sister ships, the "Exporter" is expected to meet this country's need for more and faster cargo ships. Compared with past speeds of 10 to 12 knots, the new ships are designed for a speed of 16½ knots, with a steaming radius of 15,000 miles at this speed.

The use of arc welding made an important contribution to the speedy launching of the "Exporter." The hull was approximately 40% welded with Smootharc PF-2 welding electrodes. The construction of the other ships will parallel that of the "Exporter." Down-hand welding was used on the decks, tank tops, bulkheads, pipe tunnels, and shaft tunnels.

Recent Patents

ELECTRIC SEAM WELDING

2,175,920-1. RICHARD SCHNARZ, Berlin, Germany, assigned to Westinghouse Electric & Mfg. Co., Pittsburgh, Pa. Filed respectively Mar. 6, 1937 and Nov. 12, 1937. Issued Oct. 10, 1939. In accordance with these patents seam point welding is obtained with the aid of controllable gas or vapor discharge paths. The method produces a seam weld that does not conspicuously manifest the imprint of the weld by applying sufficient current to fuse the material to be welded periodically and in the intervals between applications of sufficient current to fuse, applying current insufficient to fuse. The latter current is adjusted to such a value that the imprint is inconspicuous. Both currents are regulated independently of each other by gas or vapor discharge paths. The weld produced according to these patents is of particular value in the building of reservoirs and in the airplane industry.

WELDING SILICON STEEL

2,176,602. WESLEY J. BECK and ALVA E. TAYLOR, Middletown, Ohio, assigned to The American Rolling Mill Co., Middletown, Ohio. Filed Feb. 2, 1933. Issued Oct. 17, 1939. A process of butt welding silicon steel sheets, which consists in cutting the edges of the sheets to exact parallelism, clamping the edges into complete abutting contact throughout the joint to be welded, supporting the actual edges of the sheets beneath the butted joint, and welding the metal of the sheets together by means of a neutral gas flame, while excluding oxygen from the weld upon the side opposite the flame. By this process it is possible to weld strips of silicon steel and then form coils or long lengths suitable for cutting out parts of laminated cores and the like for electrical instruments and parts. There has been considerable effort directed to the forming of continuous strips of silicon steel for use in punch presses. Silicon steel is brittle to a degree when cold, and is more ductile under a slight rise of temperature. Moreover, this steel has a scale difficult to deal with. In addition, silicon steel oxidizes readily, producing silicon dioxide, which tends to prevent a welding action. The process of the patent permits standard silicon steel sheets of regular rolling mill width to be butt welded by gas without flux or solder.

» «

WELDING TORCH

2,176,813. GEORGE L. HAMMON, Berkeley, Calif. Filed Nov. 8, 1937. Issued Oct. 17, 1939. Ordinarily during the changeover

Replaceable jaws made of Mallory 3 Metal easily double the life of the holder.

There isn't any question about the fact the JACKSON Insulated Holders, (Models A-1, A-2 and A-3) when measured on the basis of holder cost per welding hours of life, are the cheapest you can buy. Certainly, from the standpoint of *safety* and reduction of work spoilage, they are in a class by themselves. Also, they are well ventilated—*work cool. If your dealer can't supply you, please write to us.*

Model A-2, above, 300 Amps. Replaceable jaws take rods from 1/16" to 1/4". Also available in 500 Amps. (A-3) and in Model A-1, same as A-2 but without replaceable jaws.

IN CANADA:
Hollup Corporation Ltd., Toronto, Ont.
Paragon Supplies, Ltd., Vancouver, B. C.

EXPORT MANAGERS:
International Technique, 381 Fourth Ave.
New York City

JACKSON ELECTRODE HOLDER CO.
15122 Mack Avenue Detroit, Michigan

from a welding torch to the cutting attachment, the metal mating surfaces of the couplings, one on the end of the handle and the other on the end of the cutting or welding tool, are exposed and subject to injury by denting or scuffing. After slight use it is difficult to secure these parts together with a leak-tight fit. Moreover, making the changeover requires the use of a wrench and is time consuming. The invention provides an improved coupling member for use in attaching the cutting tool to the handle. The improved coupling is capable of effecting a durable leak-tight fit.

» «

Gas Welder Control

2,177,276. James H. Bucknam, Cranford, N. J., assigned to The Linde Air Products Co., of Ohio. Filed Dec. 26, 1935. Issued Oct. 24, 1939. A novel method of controlling a welding operation by means of a photo-electrical unit is described. The process covers welding a ferrous metal article along a predetermined line and initiating relative movement between the metal article and a source of heat photo-electrically in response to a predetermined intensity of radiant energy emitted by the heated area at the starting point. Progressive heating takes place along successive portions of the metal article along the line of weld. The relative movement of the heat source and the article is stopped at any point along the welding line photo-electrically in response to a decrease to below the predetermined intensity of emitted radiant energy.

» «

Structural Welding

2,177,831. Clyde F. Kaunitz, Bay City, Mich., and Francis M. Gunn and Harry S. Boles, Chicago, Ill. Filed July 1, 1937. Issued Oct. 31, 1939. To weld framework and sheets used in making steel cars, coaches, tractors, large containers, and railroad equipment, a self-propelled superstructure carrying a welding machine adjustably mounted thereon for horizontal and vertical movement is provided. The welder is adapted to progressively spot weld the horizontal, vertical, and curved seams and members of large work pieces. The superstructure carriage moves at a predetermined speed, either continuously or intermittently. The welder is suitable for seam or line welding as well as for spot welding.

Welding Coated Metal

2,177,868. Edward C. Chapman, Lookout Mountain, Tenn., assigned to Combustion Engineering Co., Inc., New York, N. Y. Filed June 8, 1937. Issued Oct. 31, 1939. The welding of steel sheets lined with a protective coating of non-corrosive metal or alloy is effected to obtain a finished product having a uniform coating over the welded steel. The coated pieces to be welded are prepared by removing the coating adjacent to the edges of the pieces to be welded and beveling the coating edges outwardly. The steel portions of the pieces are welded, and the clear space between the edges of the coating is filled with a strip of metal similar to the coating metal. The strip is of such width and has edges so shaped as to fit closely between and to contact the edges of the coating layer in overlying relation. The strip is of lesser thickness or depth than the coating layer. The strip is then welded in place by weld metal of the same composition as the layer and strip, fusing the strip to the coating layer and filling the space above the strip to a level substantially flush with the coating layer. This method of welding is also suitable for welding steel sheets which have a superlayer of welded material. The finished product is characterized by a continuous bond co-extensive with the welded sheets.

» «

Welding Tubes

2,177,995. Walter R. Ramsaur, Racine, Wis., assigned to Young Radiator Co., Racine, Wis. Filed April 5, 1937. Issued Oct. 31, 1939. This patent applies to the welding of tubes such as those used in heating coils, radiators, condensers, and the like. The object of the patented process is to make a welded joint without accumulation of oxide scale on the inside of the tube, which scale is caused by the presence of air in the tube. The air in the tube, when subjected to heat of oxidizing temperature, forms a scale which is difficult to remove. The process consists first of forming a reduced outlet at one end of the tube and inserting a gas supply valve fitting in the other end, next in forcing the air out of the tube by means of a surge of gas, next igniting the gas discharged from the reduced end, then welding the joint while the flow of gas is continued by supplying heat and bonding material to the exterior of the joint.

Strip Welding

2,178,451. Homer W. Jones, Westfield, and Alfred J. Miller, Cranford, N. J., assigned to Oxweld Acetylene Co., of West Virginia. Filed Nov. 14, 1936. Issued Oct. 31, 1939. In making butt-welded pipe it is necessary to heat the strip to bending temperature and the edges to welding temperature. The patented process involves heating the exposed edge of the workpiece to be conditioned for seam welding, by converging rows of high temperature heating flames directed to impinge against the side of the edge, so as to concentrate the heat in the central region of the side, and directing additional combustion supporting gas between the converging rows of flames.

» «

Welding Control

2,179,326. Meril L. Eckman, Cleveland, Ohio, assigned to The American Coach & Body Co., Cleveland, Ohio. Filed July 5, 1938. Issued Nov. 7, 1939. Welding apparatus of the type which includes long flexible conductors with electrodes positioned at the ends thereof presents a difficulty, in that the operator may not know precisely when he is exerting adequate pressure of the electrode against the work to make a satisfactory weld. This pressure must vary with the gauge of metal to be welded. The invention automatically requires the application of a predetermined pressure between electrode and work before current can flow. The nvention also includes a device which may be calibrated for metals of different thickness so that the operator may be able to control the pressure exerted to suit any gauge of metal to be welded.

Trade Literature

200 Ampere Arc Welder—Lincoln Electric Co. has issued a four-page bulletin describing its 200-amp. "Shield Arc Junior" welder equipped with self-indicating dual-continuous control. Operating features are clearly explained and a number of welder applications are shown.

» «

Welding Accessories and Electrodes—Hobart Brothers Co., Troy, Ohio, has issued a pocket-sized booklet describing its line of electrodes, electrode holders, hand shields, protective clothing and accessories.

4 FINER SAFEGUARDS for the Welding Engineer!

M. S. A. COMBINATION SKULLGARD-WELDING SHIELD

Skullgard's famous head protection, now joined with a one-piece, tilting welding shield! Shield has leakproof lens holder, cap-type Skullgard may be removed and worn for other work when desired. Write for Bulletin CE-6.

M. S. A. WELDING HELMETS

The finest welding protection available. Our complete line meets every welding requirement, with each helmet designed for utmost comfort, safety, efficiency and service. Simple but positive lens-locking device; choice of standard shades of welding plates. Write for Bulletin CE-8.

M. S. A. SPEEDFRAME

Speeds production welding jobs by saving continual hand-adjustment of welders' goggles—a nod of the head positions goggles or throws them up out of way; goggles remain in either position without further adjustment. Lightweight frame is fully adjustable, standard welders' goggles or coverglass goggles supplied. Bulletin No. CE-7.

M. S. A. COATED COVER GLASS

Prevents pitting, clarifies vision, resists heat, outlasts ordinary glass 10 to 50 times! Specially treated glass is processed on one side; positively prevents molten sparks from fusing to its surface; obviates blurred vision and resultant inferior work. A revolutionary improvement—write for Bulletin No. CE-5!

MINE SAFETY APPLIANCES CO., Braddock, Thomas & Meade Sts., Pittsburgh, Pa., *Representatives in Principal Cities*

HOBART TRANSARC WELDER—A four-page folder prepared by Hobart Brothers Co., Troy, Ohio, announces the new Hobart Transarc A-C. Welder. This unit is rated at 20 to 200 amps. for operation on 220-volt, single-phase. A simple handwheel control regulates welding current in 30 steps. This machine can be purchased on the monthly payment plan.

» «

WROUGHT IRON HANDBOOK—A. M. Byers Co., Pittsburgh, Pa., producers of wrought iron and steel tubular products, has issued its newly revised handbook on wrought iron. This book was published first in 1936 as a reference book for engineering organizations and is used as a standard engineering textbook in many technical schools and colleges. The book has been completely rewritten and several chapters have been added. The commercial slant is avoided and it is claimed to be the only up-to-date publication on wrought iron, its manufacturing processes, characteristics, and fields of usefulness.

The book is priced at $1.00 per copy, but the company states that industrial executives and engineers can obtain a copy gratis by requesting it on their regular business letterhead.

» «

TRICKY WELDING PROBLEMS

"Welding Hints" is a new service recently inaugurated by the Harnischfeger Corp. of Milwaukee, Wis. This service is designed toward effecting savings of money and time —and maintaining machines, making emergency repairs, and replacing or rebuilding worn parts.

The "Welding Hints" consist of new and puzzling welding problems together with their solutions. They are printed on handy cards; and new additions to the series are made regularly. Each card handles a specific problem. Some of the problems dealt with are: The rebuilding of worn parts such as dipper teeth, side cutters, mining machinery, farm implements, etc.; building up of cutting tools; making of welded gears; rebuilding of sprocket teeth; welding of pipe structures; reclaiming of clutch pinions; and fast welding for poor fit joints.

This series should be interesting to welding shops. Industrial plants should also find them of value from the maintenance angle. Further information can be obtained by writing to Harnischfeger Corp., Welding Division, Milwaukee, Wis.

» «

NEW BOOKLET ON WRINKLE BENDING PIPE

A booklet describing the recently perfected wrinkle-bending method for bending pipe has been announced by The Linde Air Products Co. This process is finding wide application, particularly in the installation of cross-country pipelines, or wherever else pipe must be "tailored" to fit. It depends upon the use of the oxy-acetylene flame for heating a narrow band about halfway around the pipe at the point at which a change in direction is desired. When this band has reached a red heat the pipe is bent mechanically, with the heated portion at the inside of the bend. This causes a slight upsetting of the heated metal and produces a change of direction of from 4 to 6 deg. When greater changes in direction are required, a series of wrinkle bends result in a smooth, long sweep bend of any desired angle. The upset metal projects outwards from the inside of the bend, thus not interfering with the flow of fluid through the pipe and without restricting the diameter at the bend. The wrinkle-bending process is fully described in the booklet, together with suggestions for mechanical bending of pipe. Copies of this four-page illustrated booklet, 8½ x 11 in. in size, and entitled "Wrinkle Bending" are available from the nearest office of The Linde Air Products Co.

» «

BOOKLET ON "FLAME-GOUGING" — Flame-gouging, an oxy-acetylene practice for grooving steel in preparing plate edges for welding is described in a recently published booklet. The material is contained in an illustrated 8-page booklet, 8½ in. x 11 in.

The flame-gouging process was developed originally for removing metal from the underside of welds and for removing defects revealed visually or by x-ray. It is now used for a variety of other operations, including the making of U-grooves in plate edge preparation. The booklet discusses various flame-gouging applications, and a description of the equipment and technique for applying the process. Photographs of actual applications and numerous sketches are included, as well as tables of operating data.

Copies of this booklet are available from the nearest office of The Linde Air Products Co., or from the company's headquarters office at 30 East 42nd St., New York City.

FOR QUALITY WELDS
Specify
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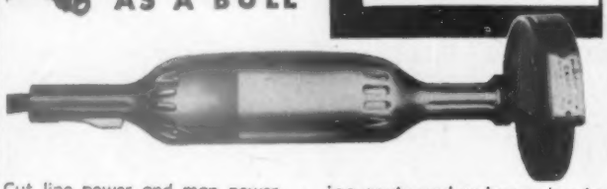

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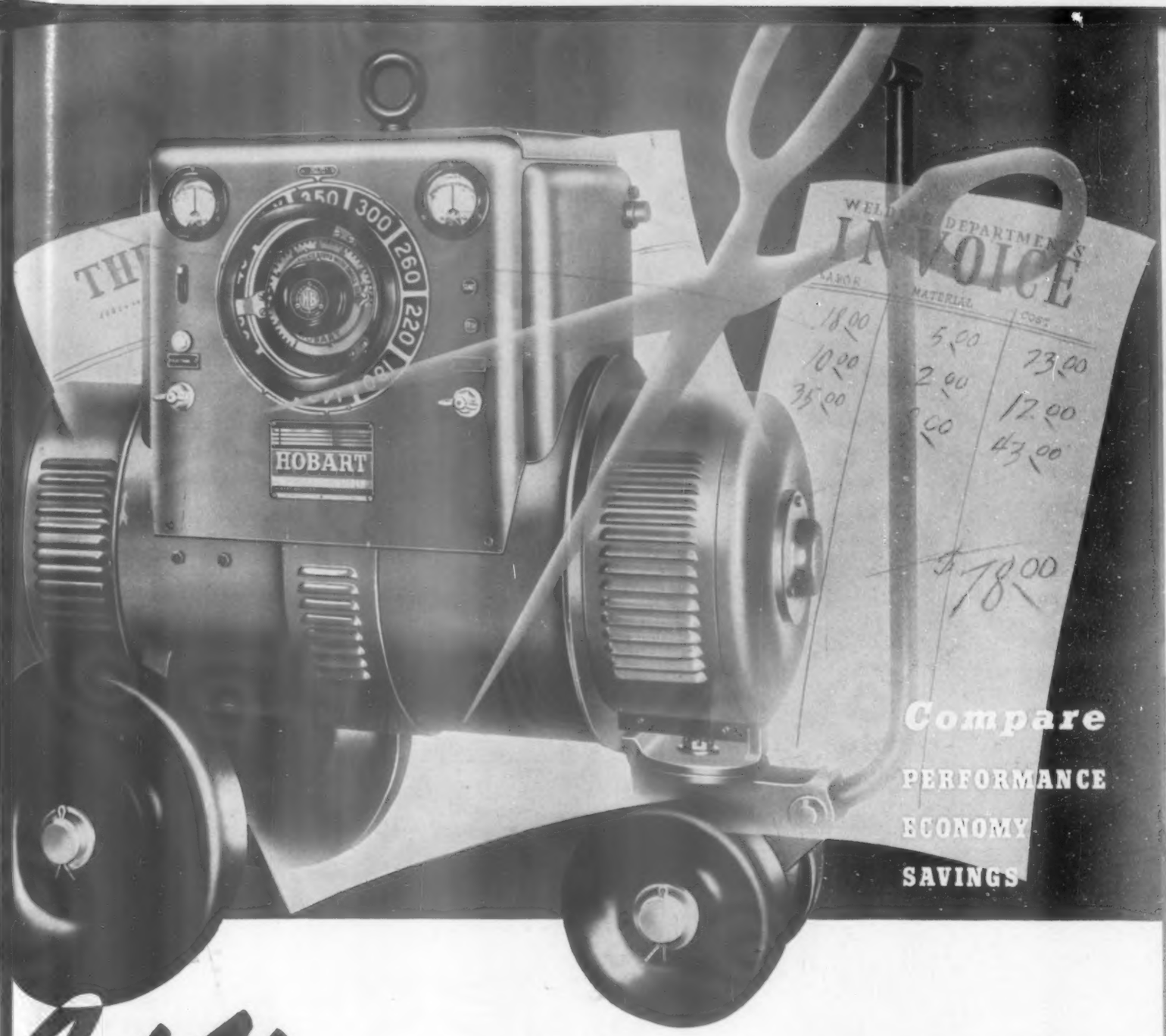

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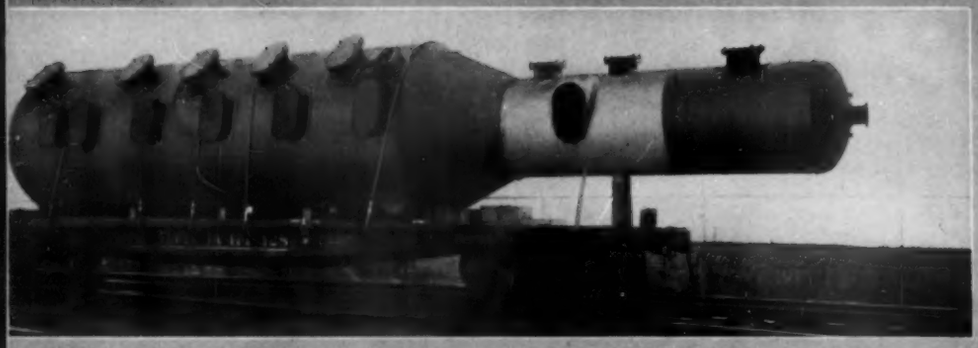
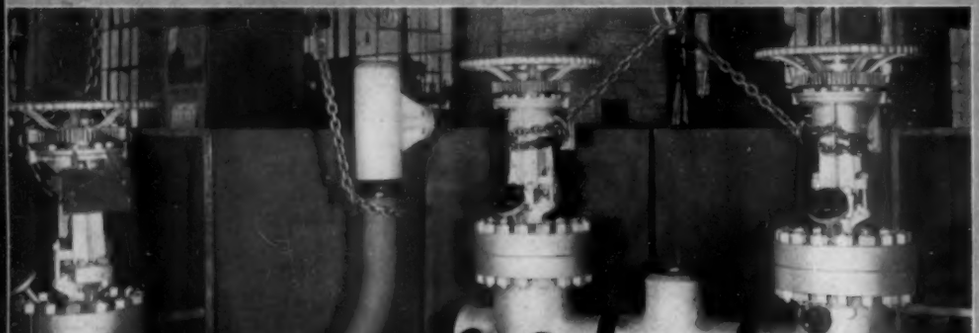


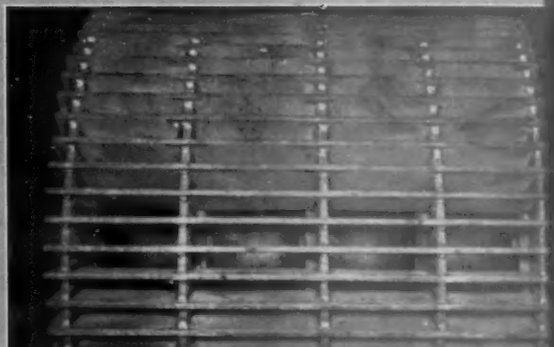
1 "It's easy to qualify welders with Murex," says one manufacturer. And that saves money for makers of oil refinery equipment like this fractionating tower, built to A.P.I.-A.S.M.E. standards. *Photo courtesy Edge Moor Iron Works, New York City.*



2 Production of fabricated piping was speeded 100% in one Michigan plant—a job that took hours is now done in minutes. *Photo courtesy George B. Limbert Co., E. Chicago, Ind.*

3 Quarter inch fillets are made in 30% less time since using Murex at a leading Pennsylvania fabricator's. Such savings are important in production jobs like the welding of this shovel bed. *Photo courtesy The Hanson Clutch & Machinery Co., Tiffin, O.*

4 Reports from plant after plant say welders prefer Mur because smooth clean deposits and easy-to-remove sla save time and trouble. *Photo courtesy Blaw Knox Co., Bla Knox, Pa.*



5 Murex proved 37.5% faster for downhand work in tests ru by a large Detroit manufacturer. Think of the savings thi means in building complicated structures requiring hundred of feet of welding. *Photo courtesy United Welding Co., Middle town, O.*

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Haynes Stellite Alloy Reduces Wear and Saves Money

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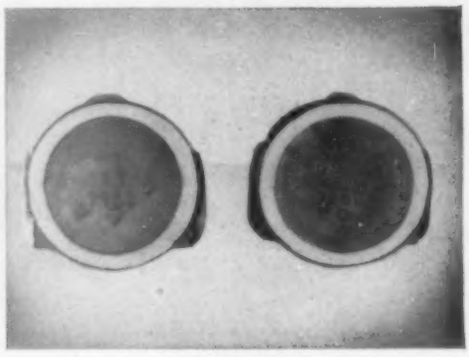
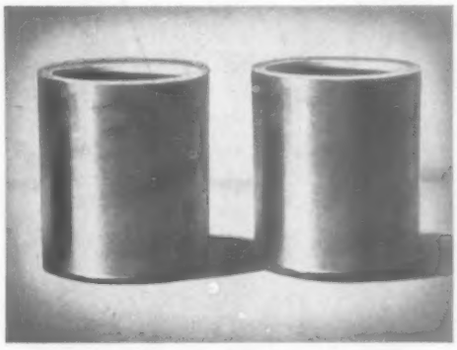
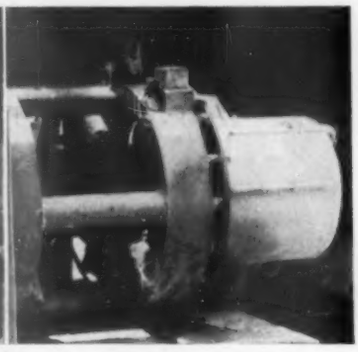
Exhaust valves and seats wearproofed with Haynes Stellite alloy were in good condition after 90 days' service in a 250 h.p. gas engine. Before hard-facing was adopted, these parts wore out in 20 days.



Disks for 7-in. Christmas tree valves, hard-faced with Haynes Stellite alloy, resist abrasive and corrosive crudes.



Refinery pump shaft sleeves, 8 in. O.D. by 11 in. long, protected from wear by Haynes Stellite hard-facing alloy.



This extrusion nozzle (left) is used in the apparatus shown (right) for coating oil pipe with a mastic of asphalt and mineral aggregate. Nozzles used to last 18 hr. but this hard-faced one will last indefinitely.

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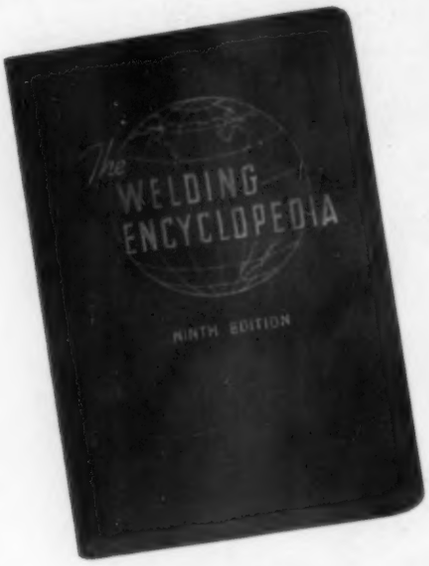

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Boiler Welding—What are the provisions of A. S. M. E. Boiler Construction Code? What are limits of pressure and temperature under Paragraph U-69?

What is the temperature of the oxy-acetylene flame? The electric arc? Thermit reaction?

What metals, welding methods and procedures are used in aircraft welding?

What method of welding has greatly simplified the welding of copper?

Does the oxy-acetylene cutting flame have any effect on cut edges of steel?

What are the common "Designs" of welds? Where and how are they used to best advantage?

What properties and characteristics would you look for in selecting electrodes for resistance welding?

How would you go about redesigning machinery for welding? Can a combination of steel castings and rolled steel be used to advantage?

Can malleable iron be welded? What are characteristics of this metal? How can you identify it?

Where is manganese steel used most widely? What should be known about this metal before starting to weld?

What are the melting points of various metals?

What should the welder know about the structure of metals? of the composition of metal and non-metallic elements? about the Iron Carbon Diagram? See "Metallography."

What are the possibilities of Metal Spraying? Where can it be used effectively and what metals are adaptable to such application? What results may be expected? See "Metal Spraying."

In welding stainless clad steels, what procedure would you follow? Which side should be welded first?

How does a molten puddle of steel react under the three adjustments of the oxy-acetylene flame, i.e. neutral, oxidizing and carbonizing? What flame adjustments are recommended for the different metals?

Preheating—Can you name the three important reasons for its use? How does shape of piece govern point where preheating is applied?

How many codes are in existence which govern welding? To what specific types of welded fabrication do they apply? Name requirements of each?

What is indicated by results of reduced-section tension test? free-bend test? root-break test? side-break test? nick-break test? How is each made?

Where can silver solders be used to advantage? What metals are particularly adaptable to this process? Is joint design important?

What are content and designation of the most frequently welded metals? See "Specifications for Materials."

In welding Stainless Steels, what properties of the two general classes of these metals must be kept in mind?

In designing welded Structural Joints, what unit stresses (shear, tension and compression) are permitted under A.W.S. Building Code.

What kinds of metal and what shapes are best adapted to Flame Hardening? What advantages has it over furnace hardening?

What are the various forms of welded joints? What are root, leg, toe, face and throat of a weld?

Name qualification tests required for welding large steel tanks? What is the most economical design for open rectangular tanks?

What is the reaction in Thermit welding? Where is the process especially useful and what preparation is necessary?

What shop exercises are essential in a training course for oxy-acetylene welders? for arc welders? What shop equipment is necessary? See "Training Operators."

Welding Rods and Electrodes—Specifications for various A.W.S. grades are given as well as tensile requirements of all-weld metal coupons.

How are Welding Symbols used and how do they simplify detail drawings and shop blue prints?

What is "Arcronograph," "Avialite," "Blackor," "Borium," "Calobar," "Manganal," "Polygraph"? Who makes it? All leading trade names with manufacturer's name and address are given.

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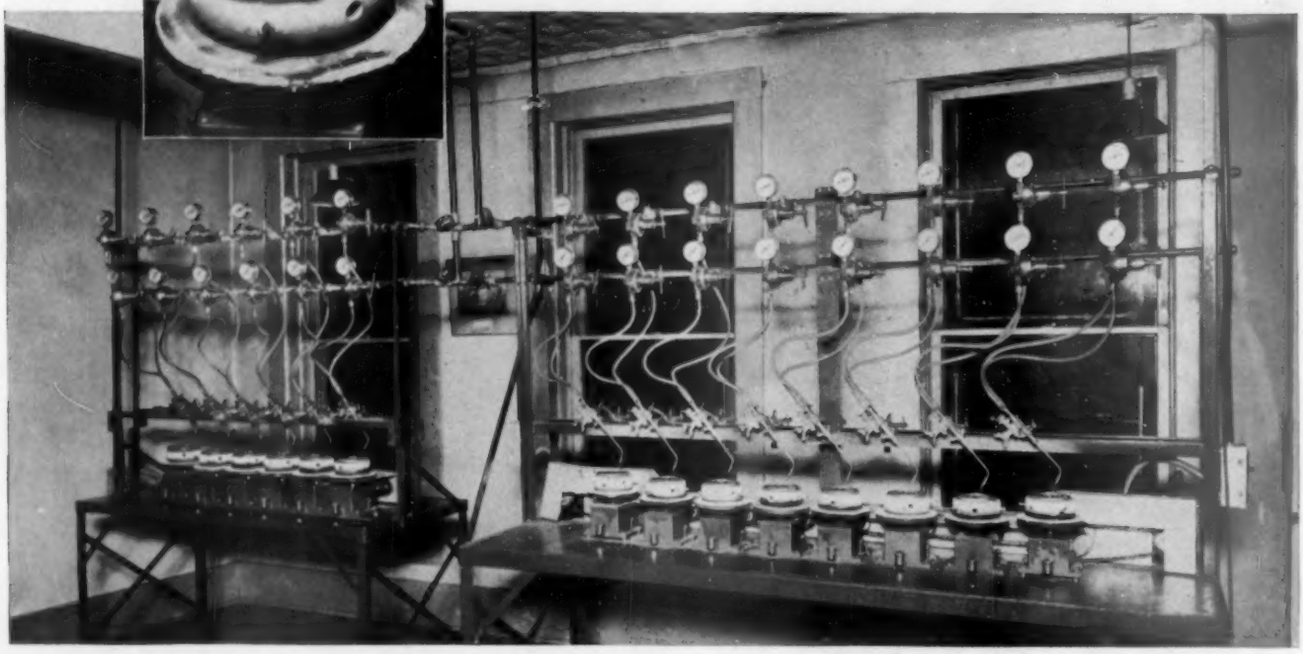

Skimming the "cream" from the crankcase oil to assure clean, viscous oil is the job being done by the Taylor Float-O-Oil suction intake. Speed plus permanent tightness are two "musts" in the assembly of this oil float.

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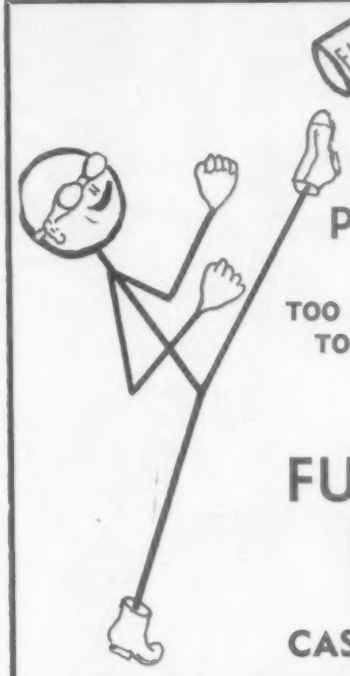

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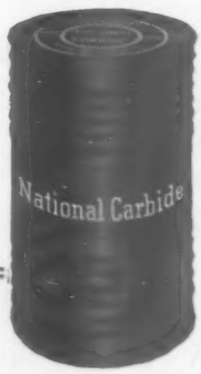

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Solution to the problem on page 51 was

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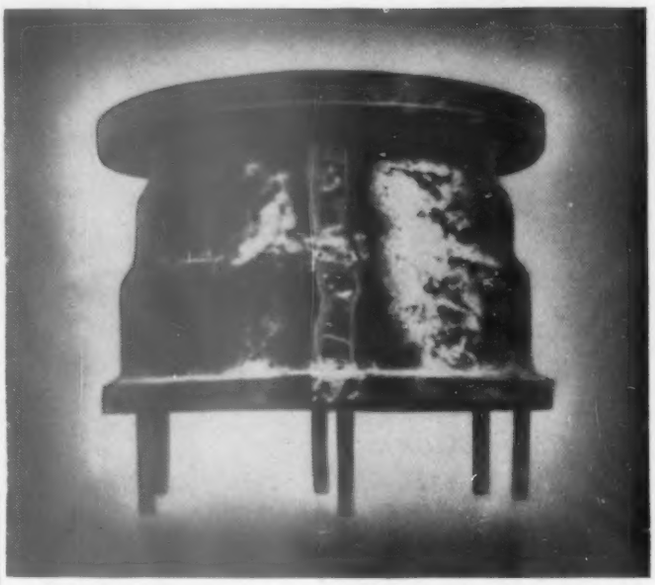

Cracked iron casting repair-welded with Tobin Bronze in one hour

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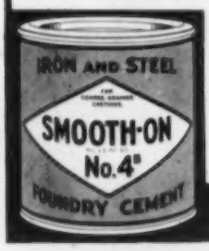

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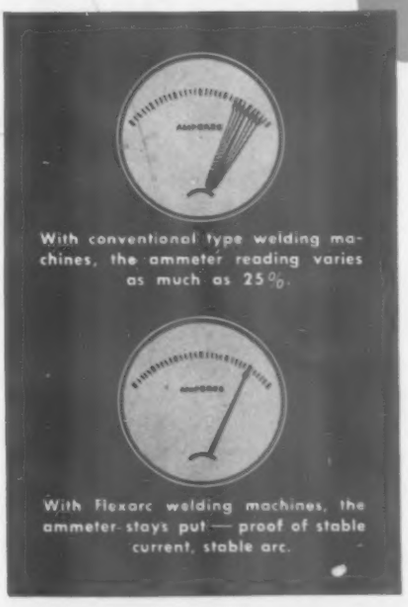
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